

**Patterns and Determinants of Consumers' Preferences and
Demand for Fruits and Vegetables in Bangladesh**

By

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Abstract

This thesis investigates the factors affecting the intake of fruits and vegetables in rural and urban Bangladesh to explore how the consumption of these foods relates to the prevalence of non-communicable diseases (NCDs). Data was collected from consumers and policymakers/experts through questionnaires, key informant interviews, and focus group discussions, with the results being analyzed via quantitative and qualitative techniques. The present study had three key objectives: i) to assess the economic factors influencing the consumption of fruits and vegetables; ii) to examine the non-economic determinants (socio-demographics, social prejudices, and practices) of fruit and vegetable consumption; and iii) to map the perceptions and knowledge of the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these food sources.

The results of this study revealed that people were inclined to buy more meat and fish instead of fruits and vegetables when their incomes increased. In addition, price responsiveness to different products (especially rice) was generally higher in rural areas, which suggests that income differences are significantly higher in these areas. Overall, gender had no significant effect on the consumption of fruits and vegetables, although women who identified as housewives tended to consume lower levels of these foods. On an average, 75-92% of study participants did not consume the recommended five servings of fruits and vegetables each day; however, there was a significant correlation between higher income and increased fruits and vegetable consumption. The perceptions of the public and experts revealed that the public generally understood and addressed their problems via first-hand experience, while the experts/policymakers relied heavily on scientific knowledge. The wide gaps in the perceptions of these groups can only be minimized through appropriate dialogue between the public/stakeholders and experts/policymakers. Therefore, government agencies and NGOs in Bangladesh should focus on increasing opportunities for education and employment (especially for women) in rural areas and on developing targeted interventions that consider geographic (urban-rural) and cultural differences.

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Preface

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The following describes the contributions of authors:

Chapter 2, entitled “Estimation of Fruit and Vegetable Demand Elasticity in Bangladesh: the QUAIDS Model for the City of Dhaka South and Rural Areas of Sylhet Division,” manuscript has been submitted and accepted by the Journal of Development Areas. The authors of this manuscript are Sadia Mustafa (S.M.) (Graduate student, Natural Resources Institute, University of Manitoba, Winnipeg, Canada), C. Emdad Haque (C.E.H.) (Professor, Natural Resources Institute, University of Manitoba, Winnipeg, Canada) and Soham Baksi (S.B.) (Professor, Department of Economics, University of Winnipeg, Winnipeg, Canada). Authors’ Contributions: S. M., C.E.H. and S.B. formulated the research questions and research design for this manuscript. S.M. performed the formal statistical analysis. S.B. provided guidance in finalizing econometric model and statistical tools. C.E.H. provided guidance in overall analysis and writing. S.M. prepared the original draft. All authors reviewed the content and agreed to the published version.

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Dedication

**This thesis is dedicated to my mentor
Late Ms. Simeen Mahmud**

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Chapter 1: Introduction

1.1 Background and Context

1.1.1 Low fruit and vegetable consumption and its implications for non-communicable diseases (NCDs)

Non-communicable diseases (NCDs) diseases have become the root cause of death globally (IHME, 2019). The proliferation of NCDs can be attributed in part to rapid changes in diet brought about by globalization, especially in low- and middle-income countries (LMICs) (WHO, 2011). Evidence suggests that dietary changes such as increased salt intake, lower consumption of fruits and vegetables, and higher intake of trans and saturated fats are directly related to increased exposure of NCDs (Aburto et al., 2013; Li et al., 2015; Miler et al., 2016). This is supported by various studies, which have also shown that the risk of NCDs is inversely linked to fruit and vegetable consumption (Boeing et al., 2012).

Fruits and vegetables are an essential source of numerous nutrients, and fiber, which all help to prevent most NCDs (Slavin, 2012). For instance, Trowell and Burkitt (1975) found that higher fiber intake can lower one's risk of developing cardiovascular disease and colorectal cancer, while Desmond's (1999) work has shown that frequent and adequate consumption of vegetables can reduce one's risk of developing diabetes, which is currently the world's fastest-growing disease. Elsewhere, a Swedish study focusing on the relationship between diet and cancer revealed a correlation between lower intake of fruit and vegetable and use of tobacco (smoke), little or no exercise, and more rapid aging in both sexes (Wallstorm, 2000). Furthermore, Wang et al. (2014) showed that death rate of people who consumed five servings of fruits and vegetables per day was 26% lower compared to people who did not consume these foods daily. Despite attempts to educate adults in LMICs, their consumption remains below the standard level of 400 grams (5 servings) per day recommended by a joint WHO/FAO workshop held in 2003 (Schneider, 2007).

Like many other LMICs, low fruit and vegetable consumption has also been recognized as a major causer for NCDs in Bangladesh (MHFW, 2010). The traditional Bangladeshi diet is heavily dependent on rice, which accounts for approximately 80% (81% in rural and 77% in urban

areas) of the caloric energy in most people's diets (Halder & Urey, 2003). At present, Bangladeshis consume, on average, 211 grams of fruits and vegetables each day—just over half of the minimum daily requirement of 400 grams (WHO/FAO, 2014). The most prominent research into social dynamics that influenced the consumption of fruits and vegetables in Bangladesh was the WHO-STEP survey (2010), which found fruit intake (on average 1 serving per day) among adult Bangladeshis to be lower than vegetable intake (2.2 servings per day). Although people reported eating vegetables six days per week on average, the quantities consumed were meager. Notably, the findings of the WHO-STEP survey also suggested that more frequent vegetable consumption is not necessarily an indication of higher health awareness; rather, people may eat more vegetables because they cannot afford expensive meat or fish, especially in rural areas (as cited in Karim et al., 2017, p. 56). However, as in many other LMICs, low fruit and vegetable intake remains prevalent among general population in Bangladesh. This dietary deficiency is partly due to non-economic factors, such as traditional dietary habits, socio-demographics, and attitudes towards food. In contrast, the economic components for reduced fruit and vegetable intake tend to be linked with lifestyle changes due to urbanizations and globalization.

1.1.2 Factors contributing to low fruits and vegetable consumption in LMICs

As with many other LMICs, the rapid economic transition sparked by globalization in the 1990s had a negative effect on dietary habits in Bangladesh. However, globalization also contributed to steady economic growth within Bangladesh; this growth has led to a ten-fold increase in per capita income over the last decade, which has in turn raised the socioeconomic status (SES) (i.e., income, education, and assets) of the population (WHO/FAO, 2014). SES is positively correlated with healthy diets in high-income countries (HICs), but this link has yet to be verified in LMICs due to a lack of sufficient research (James et al., 1997). Findings have shown that, even with the rapid economic growth experienced by Bangladesh, food still accounted for 85% of total household expenditures, with only 13% and 6% of this budget being allocated for vegetables and fruits, respectively (Awal, Sabur, & Mia, 2008).

Although demand for fruits and vegetables may rise with income, the proportion of the household food budget dedicated to fruits and vegetables has declined (IARC, 2003). This phenomenon can be attributed to the fact that it is more efficient for low-income households to satisfy their basic energy requirements with carbohydrates rather than more expensive energy

sources like fruits and vegetables. The economic growth caused by globalization has substantially altered the dietary patterns of Bangladeshis, mainly in the form of a move away from the consumption of fruits and vegetables toward a more processed "Western" diet. At present, processed foods account for more than 70% of Bangladeshi urban consumers' diets, and as much as 59% of the diets of rural consumers (Reardon et al., 2014). A national statistics revealed that, from 2001 to 2010, consumer expenditure on fast and junk food was spiraling at a rate of 15.5% every year (Bangladesh Bureau of Statistics, 2001; 2010). Compared to the convenience of processed and fast foods, cooking with vegetables simply seemed time-consuming and unappetizing for many (Blom, 2017).

Intake of fruits and vegetables is also affected by non-economic factors such as gender, educational attainment, presence of children, region, and social perceptions about diet. In the context of LMICs, the influence of age on the intake of fruits and vegetables is the least explored of these factors. However, in most countries, the 18-25 age group is considered the most vulnerable group for unhealthy lifestyle and obesity (Jekielek & Brown, 2005). While findings have shown that healthy food behaviors are stronger among married people in both HICs and LMICs, this effect is more significant for men than it is for women. The tendency for husbands to consume higher amount of fruits and vegetables after getting married might be due to having a wife who is now in charge of the kitchen. In contrast, an Iranian study found that unmarried women and married men ate more fruits and vegetables than married women and single men (Mohammadifard et al., 2006). Parental status also influences women's healthy food behaviors, however this effect is much less pronounced for men. A study in Indonesia revealed that, compared to fathers, mothers with higher nutritional education allocated major portion of the household budget to fruits and vegetables (Block, 2002).

Education and income are generally the most influential factors in determining SES. One common finding in some LMICs and most HICs is that low-SES individuals tend to eat fewer fruits and vegetables (Hosseinpour et al., 2012; Ball et al., 2015). In LMICs, low levels of fruit and vegetable consumption among this group of individuals may be due to inadequate knowledge, local production, and high prices (Mayen et al., 2014). In contrast, findings have shown that individuals in East Africa with lower income and education are inclined to eat a traditional diet of fish, rice, and vegetables (Mayen et al., 2014). These results are similar to some previously

conducted researches of LMICs, wherein traditional food was preferred among lower SES groups. Higher SES individuals tended to eat more trendy or modern food, as these dietary choices also served as markers of social status (Smith & Baghurst, 1992).

Aside from decision-making power, a study of Algerian refugees couldn't pinpoint any correlation between dietary patterns and gender (Morseth et al., 2017). In a Malaysian context, it has been seen that women are inclined to consume more fruits and vegetables as they are more at risk of dietary deficiencies. Furthermore, gender-biases in food allocation have been found to be more significant in South Asia than in Africa or Latin America (Zainal et al., 2012). Even though there was minimal gender bias in food allocation for adult males in Africa, there was no evidence that male children were favored over their female counterparts. This was not the case in South Asia (Zainal et al., 2012). Moreover, women have been increasing their fruit and vegetable intake (or abstaining from eating altogether) due to increasing social dogma regarding the "ideal" female body shape (Vlassoff, 2007).

High-earning individuals in the cities have more tendencies to consume energy-dense and fatty foods instead of fruits and vegetables, which is evidenced by the prevalence of overweight and obese urban dwellers in LMICs (Lopez-Arana et al., 2014). Additionally, the higher fat intake in these urban areas suggest wealth and easy access to supermarkets, which are also associated with high SES and urban accessibility (Popkin, 2006). Although high-fat diets are usually associated with the consumption of saturated animal fats, people in some countries (e.g., China) use vegetable oil in everyday cooking, which may increase the levels of fat in their diet. However, the health risks posed by the use of vegetable oils are minimal, as these fats are predominantly unsaturated (Popkin, 2008). Unfortunately, low-income people living in rural settings may not be able to afford or have access to expensive and healthy vegetable oil.

Lifestyle plays a significant role in determining day-to-day dietary practices. For example, exercise of any form was correlated in favour of increased fruit and vegetable consumption, while smoking was unfavourably related (Esmailzadeh & Azadbakht, 2008). Similarly, exercise, smoking, and age were prominent determinants of lower fruits and vegetables consumption in MENA (the Middle East and North Africa) (Sibai et al., 2010). In particular, the prevalence of low fruit and vegetable consumption and smoking was high across this region, and especially in

Lebanon (55%) (Sibai A M et al., 2010). Furthermore, the findings showed that middle-aged individuals (>40) tended to smoke more than younger people, and that men (48%) smoked more than women (13%) (Khattab et al., 2012). Along with high prevalence of smoking, physical inactivity was also higher in MENA. In an Indian context, Cusick and Kuch (2012) found that individuals, especially adolescents, who watched TV more than 3 hours per day or ate while watching TV tended to be more obese and consume less fruits and vegetables compared to those who did not.

Taste preference is the primary determinant of an individual's everyday diet (Drewnowski et al., 1999). While a preference for salty, spicy, sweet, meats, or vegetable could be an independent taste preference, some preferences are influenced by exposures during early childhood. For example, Birch (1999) found that the food eaten by pregnant women contributed to the formation of taste preferences in their unborn child. Similarly, the intake of fruits and vegetables as an adult depends on the eating habit of a child's adolescence (Krebs-Smith et al., 1999). Social norms and taboos regarding foods (e.g., not eating eggs before an exam or food restrictions during pregnancy) may also become entrenched during childhood.

1.1.3 The context of Bangladesh

This thesis investigates whether factors influencing fruit and vegetable consumption in LMICs are identical to the consumption patterns among Bangladeshi adults. Thus far, very few studies have specifically tested whether socio-demographics, social norms, or region influence the low consumption of fruits and vegetables in Bangladesh. An analysis of the WHO-STEP study suggests that gender, age, education, and wealth significantly affect the consumption of fruits and vegetables. For example, female (18.9%) were found to eat more fruits and vegetables than their male counterpart (15.4%). This result was similar to many studies of LMICs, which have concluded that female in general are more conscious of healthy dietary practices than the male (Mayen et al., 2014). However, the reasons for higher fruit and vegetable consumption among Bangladeshi women may not be the same. Since women in Bangladesh are likely to be forced to eat leftovers or to eat after rest of the family has complete their meal, they are often left with only vegetables or pulses, as the meat has already been eaten (Karim et al., 2017). This is particularly relevant in rural contexts in Bangladesh. Wealth and educational attainment have also been detected to be positively related with increased fruit and vegetable consumption (Karim et al.,

2017). Education generally results in greater knowledge regarding nutrition and the benefits of fruits and vegetables; however, individuals with lower levels of education and wealth usually belong to disadvantaged social groups who face a significant challenge in simply securing enough food, let alone fruits and vegetables.

To promote healthy dietary habits and decrease the number of non-communicable diseases, the Government of Bangladesh has undertaken numerous policy initiatives. Studies conducted by the Bangladesh Bureau of Statistics (2003, 2010) have shown that increases in income have resulted in higher consumption of rice and cereals, but not vegetables. A separate study revealed that, in Bangladesh, people in the highest quartile for wealth and education are 61% less likely to eat inadequate amounts of fruits and vegetables compared to those in the lowest quartiles (Karim et al., 2017). *However, the question remains: is increased fruit and vegetable consumption more influenced by economic factors (e.g., earnings, price, accessibility) or noneconomic elements (e.g., taste, habit, social desirability, or demographic characteristics).*

Compared to HICs, very few LMICs make a nation-wide effort to document dietary patterns, including fruit and vegetable consumption, by social and economic standing (Mayen et al., 2014). Most current studies have worked on large scale data from different countries to determine dietary patterns or proportions (Kastorini et al., 2011; Subramanian et al., 2011; Mayen et al., 2014). With the exception of Brazil, China, India, and Indonesia, very few LMICs maintain detailed longitudinal data (Popkin et al., 2006). Moreover, none of the studies that include Bangladesh contain country-specific trends relating to fruit and vegetable consumption, specifically in regard to urban-rural differences. In general, research has indicated that people in HICs eat adequate amounts of fruits and vegetables, while those in LMICs are less likely to do so. There are two major gaps in the existing literature relating to LMICs and Bangladesh: a lack of rigorous data and superficial analyses of dietary patterns. Most research focusing on Bangladesh has consisted of demand analyses of aggregated food items or the consumption of vegetables, rice, or potatoes using a narrow economic lens (Alamgir & Belrage, 1973; Huq, 2004; Awal et al., 2008). The only study that has applied social dynamics to investigate patterns of change in dietary habits was the 2010 WHO-STEP survey.

The preceding discussion suggests a serious deficiency in dietary and nutritional knowledge and data relating to consumer preferences for carbohydrates and processed foods over fruits and vegetables in a Bangladeshi context. Since an increase in the consumption of nutrient-rich fruits and vegetables would promote healthy and sustainable diets and help to prevent NCDs (WHO, 2011), it is imperative that research be conducted to fill the knowledge gaps relating to the barriers and drivers of fruit and vegetable intake among the people of Bangladesh.

1.2 Research Purpose and Objectives

Given the prospective social, environmental and personal benefits of consuming higher volumes of fruits and vegetables, the present study seeks to examine potential drivers, impediments, and means to increasing fruit and vegetable consumption in Bangladesh. This research has three key objectives:

- i) to assess the economic factors influencing the consumption of fruits and vegetables (e.g., income elasticity and price elasticity);
- ii) to examine the non-economic factors affecting fruit and vegetable consumption, including demographic characteristics (e.g., education, gender, wealth, presence of children, region), popular social beliefs, and prejudices; and
- iii) to map perceptions and knowledge among the public and experts/policymakers regarding the low levels of fruit and vegetable intake in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these food sources.

1.3 Methodological Approach

Two different strategies will be necessary to achieve this study's three research objectives. To achieve the first and the second objectives, it will be necessary to examine the correlations between the respondents' economic and non-economic characteristics and their patterns of fruit and vegetable consumption. Thus, a quantitative approach using the most appropriate statistical models will be most appropriate for analyzing these relationships (Creswell, 2009).

The third objective is to identify the gaps and juxtapositions in expert/policymaker and public understandings of the knowledge, impediments, and means to increasing fruit and vegetable

consumption. To achieve this goal, an open-ended survey instrument will be administered in participatory settings, as it is implied that a qualitative approach is best suited for this part of the investigation (Creswell, 2009). Both qualitative and quantitative data will be collected simultaneously due to time and budget constraint.

1.3.1 The study area and study population

The study was carried out in urban and rural residential communities in Bangladesh. This locational differentiation captures the two major types of residential communities in Bangladesh. As this study is part of a multicomponent project, entitled, *Reducing Dietary Related Risks Associated with Non-Communicable Diseases (NCDs) in Bangladesh*, which is funded by the International Development Research Centre (IDRC), the proposed study area was purposively selected from the project's study areas.

The urban respondents were selected from four wards (new ward numbers 1, 11, 40, and 41) from the city corporation of Dhaka South, while the rural respondent was selected from three *upazilas* (third tier administrative unit) from Sylhet *Division* (first tier administrative unit), namely, Borolekha and Kamolgonj from Maulovibazar *District* (second tier administrative unit) and Deraï from Sunamganj *District*.

A total of 501 households—200 urban households and 301 rural households—were selected for the studies intended to achieve the first and second research objectives. Selection was conducted via proportionate stratified sampling of the population in the area, using household wealth serving as the strata. The information was collected from the baseline data of the ongoing IDRC project. Proportionate stratified sampling is a probability sampling technique wherein the population is known and divided into different subgroups or strata (Thompson, 2012). The final respondents were later selected at random from different subgroups. This sampling approach is popular, as each stratum is representative of the various age groups, socioeconomic classes, and genders residing in the study areas.

For the third objective, the samples for the key informant interviews (KIIs) and focus group discussions (FGDs) was comprised of members from two stakeholder groups: i) consumers, and ii) experts/policymakers. The consumer group (buyers of fruits and vegetables) was selected

randomly from the IDRC Project baseline survey, and excluded those who were affiliated food-supplying jobs or the food-policy-making process. Policymakers were chosen from a wide range of government departments and reputable organizations in the field of agriculture and food policy formation and implementation.

According to Krueger and Casey (2000), a standard focus group should include six to eight participants. They also recommend to never exceed 10 participants, as groups larger than this size are much more difficult to manage. For example, if the participants are not given ample opportunity to share their views with the group, they may start whispering to the person next to them—a classic signal that the focus group is too large. Therefore, we conducted four FGDs containing a total of 30 respondents and seven KIIs. Qualitative and quantitative data were collected simultaneously from October 2018 to December 2018, and interviews were carried out at a time that was deemed convenient for the participant and after receiving their verbal or written consent.

1.3.2 Data collection method

For the first and second objectives, a broad quantitative household survey was administered the sample population, while qualitative methods (e.g., focus group discussions) aimed at gaining a detailed understanding of the participants' perceptions and knowledge were applied to pursue the third objective (Cresswell, 2009).

For the first and second objectives, a survey was used to collect data from a total of 501 households in the two areas (i.e., 200 urban and 301 rural). The distribution of the sampling units (households) was proportional to size (PPS) of urban-rural (60%-40%) ratio. The last stage of the sampling procedure involved a stratified sampling strategy (Thompson, 2012) based on the wealth and socioeconomic status of each household, using baseline data from the previously-conducted project surveys. The respondents from each wealth stratum within each *Upazila* were then selected randomly.

Only the head of the household or the lead woman (e.g., wife) were interviewed. The survey aimed to identify patterns in consumption and expenditure on fruits and vegetables, and to

assess whether these habits were related to the economic and non-economic characteristics of the household or household head. The survey had 11 modules in total, of which module 1 to module 7 were completed by all 501 participants (Appendix 5). These 7 modules included information related to the respondent's sociodemographic features, diet in the last 24 hours (obtained using the recall method), food related knowledge, attitude and practice table (with Likert response), tobacco use, and other health conditions.

Considering time and budget constraints, a detailed food and non-food expenditure survey was also administered to a select number of households in rural and urban areas based on participant willingness. This was part of module 8 to module 11 in the survey (Appendix 5). In total, 211 households (141 in rural areas and 70 in urban areas) completed the expenditure survey. Thus, the ratio of urban-rural population on expenditure data was slightly different (urban 33% and rural 66%) than the desired ratio of rural 40% and urban 60%.

For the third objective, qualitative data-collection tools (i.e., FGDs and KIIs) were employed to collect more detailed information relating to the barriers to and facilitators of fruit and vegetable consumption. Four FGDs were facilitated with general consumer groups from rural and urban areas. All recruited participants were over 18 years of age, consisted mostly of women, and provided written or verbal consent to their participation in, and our recording of, the interviews. Notably, male household members were largely unable to participate in these discussions, as the interviews were conducted during the daytime. In the FGDs, the participants were asked to discuss their experiences regarding the barriers and drivers of fruit and vegetable intake. In contrast, the perceptions and knowledge of the experts/policymakers were probed through seven KIIs. In these interviews, the researcher facilitated the discussion and acquired the participant's written and oral consent to record the conversation. No one was compelled to participate against their will, and all respondents were allowed to decline or withdraw at their convenient time.

Table 1. 1: Methods of data collection and rationale

Research Objectives	Method	Sample	Rationale
<i>1. To assess how economic factors (e.g., price and income) influence the consumption of fruits and vegetable.</i>	Household survey (Expenditure survey)	200 HH (urban) 301 HH (rural)	<ul style="list-style-type: none"> • Rural-urban differences. • Expenditure survey to determine income and price elasticity.
<i>2. To examine non-economic determinants, including demographic characteristics (gender, education, wealth, presence of children, region), popular social beliefs, and prejudices.</i>	Household survey	200 HH (urban) 301 HH (rural)	<ul style="list-style-type: none"> • Influence of sociodemographics on food intake. • Gender dimensions. • Rural-urban differences.
<i>3. To map the perceptions and knowledge of the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these food sources.</i>	FGD and KII	4 FGDs (public) 7 KIIs (expert-policymakers)	<ul style="list-style-type: none"> • The general public's perceptions regarding consumption. • Perception of experts/policymakers regarding consumption.

1.3.3 Data analysis

The first objective requires a demand analysis of fruits and vegetables using price and income (expenditure) elasticity. The theoretical model most commonly used for such analysis is Deaton and Muelbauer's (1980) Almost Ideal Demand System (AIDS). This model helps to explain expenditures on fruits and vegetables or the price of the commodity. Ultimately, this model allows us to find the income elasticity and price elasticity of different fruits and vegetables.

The second objective explores the demographic and attitudinal components that influence participants to eat less fruits and vegetables. To this end, an ordered logistic regression analysis was applied to illustrate the relationship between various non-economic components and low intake of fruits and vegetables.

For the third objective, the KIIs with the experts/policymakers and FGDs with general consumers were transcribed verbatim from the audio recordings. To analyze the collected qualitative data, a thematic analysis approach was taken to determine emergent themes and subthemes relating to the knowledge and perceptions of the public and experts/policymakers. The formulation of the perception and knowledge models for the public and experts/policymakers was inspired by a modified mental model approach.

1.4 Contribution of the thesis to the Research Project

This thesis is a subcomponent of a major project entitled, *Reducing Dietary-Related Risks Associated with Non-Communicable Diseases in Bangladesh*, which is being funded by the International Development Research Centre (IDRC) (Ottawa, Canada) through the Canadian International Food Security Research Fund (CIFSRF). The main objective of this collaborative research is to obtain evidence relating to policies and practices across sectors that will help reducing non-communicable diseases in Bangladesh. One sub-objective of the project is to improve our understanding of the determinants driving demand for fruits and vegetables, and to determine resources for promoting and supporting a dietary shift towards increased vegetable consumption. The current study attempts to provide a more robust understanding of several economic and non-economic determinants of fruit and vegetable intake, and the complex perspectives of experts/policymakers and the general public. The findings of the current study are expected to inform future research directions, interventions, and policymaking aimed at increasing fruit and vegetable consumption and, thus, reducing the prevalence of NCDs.

1.5 Organization of the Thesis

A “sandwich,” or grouped, manuscript style was adopted in preparing this Master’s thesis. This thesis consists of three journal manuscripts, accompanied by an introduction (Chapter1) and a discussion and conclusion chapter (Chapter 5). Chapter 2, 3 and 4 were the three manuscripts that were prepared according to the main objectives of the thesis. The style of each chapter was tailored according to the guidelines of the intended journal. Manuscript 1 (Chapter 2), which focuses on the demand elasticity of fruits and vegetable consumption in Bangladesh, has been accepted for publication in *The Journal of Development Areas*. Manuscript 2 (Chapter 3), which examines the

influence of demographic factors and behavioral practices on low intake of the fruits and vegetables, has already been published in *Nutrients*. Manuscript 3 (Chapter 4) maps the perceptions and knowledge of the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladeshi society, and identifies the facilitators and barriers to increasing the consumption of these food sources. This manuscript has been submitted to *Public Health Nutrition* for publication. Lastly, the final chapter (Chapter 5) provides a discussion and summary of all the manuscripts, along with directions for future research.

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Chapter 2:

Estimation of Fruit and Vegetable Demand Elasticity in Bangladesh: the QUAIDS Model for the City of Dhaka South and Rural Areas of Sylhet Division¹

Abstract

The present study seeks to examine consumer demand for fruit and vegetables and potential economic responses to changes in income and price in urban and rural Bangladesh. Despite efforts by the Government of Bangladesh to promote fruit and vegetables in order to reduce the incidence of non-communicable disease, per-capita daily intake has remained as low as 211 grams compared to the minimum requirement of 400 grams. Although the existing literature indicates some regional and gender-based variation in vegetable intake, specific knowledge of this variation remains poor. Recognizing the urgency of reducing non-communicable diseases, a primary household expenditure survey was conducted between 2018 and 2019 in selected communities of the City of Dhaka and rural areas of Sylhet Division. The purpose of the study was to estimate the demand for fruits and vegetables based on household income and the price elasticity. These estimates were analyzed by the nonlinear Quadratic Almost Ideal Demand System (QUAIDS) model.

The results revealed that expenditure on fruit and vegetables was not significantly different between male and female-headed households, while in urban areas a rise in income led to greater spending on fish, meat, fruit, and milk rather than vegetables. Pure price effect also showed that vegetables were not yet an established substitute for fish and meat.

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Authors' Contributions: S. M., C.E.H. and S.B. formulated the research questions and research design for this manuscript. S.M. performed the formal statistical analysis. S.B. provided guidance in finalizing econometric model and statistical tools. C.E.H. provided guidance in overall analysis and writing. S.M. prepared the original draft. All authors reviewed the content and agreed to the published version.

The QUAIDS model was used along with the survey data to estimate the income elasticity and price elasticity of seven food groups (vegetables, fruit, rice, wheat and pulses, fish and meat, spices, milk) according to geographical region. Notably, higher income tended to increase consumption of vegetables and rice more in rural areas (vegetables 1.01 and rice 0.81) than in urban areas (vegetables 0.94 and rice 0.15). Female-headed households did not exhibit significantly different fruit and vegetable consumption compared to male-headed households, though it is possible that greater income-generation opportunities in rural locality might increase the decision-making power of women and lead to an improvement in dietary behavior. Further policy attention should be given to public campaigns and social marketing regarding the health benefits of fruit and vegetable consumption accounting for different social class and cultural norms in the rural urban areas.

Keywords: Income elasticity, Price elasticity, Fruit and vegetables demand, Bangladesh.

2.1 Introduction

Bangladesh is going through a rapid epidemiological transition in recent times. More than 63% of the total deaths in Bangladesh during 2019 were due to non-communicable diseases (NCDs) (WHO, 2020). The primary reason for the increase is change in dietary habit, food insecurity, and urbanization. In terms of traditional dietary habit, caloric intake of the people of Bangladesh are highly unbalanced, with more than 80% of calorie coming from rice and only 3% from vegetables (Halder & Urey, 2003). As a result, Bangladesh has seen a growing incidence of nutrient deficiency diseases, especially among children, women, and the poor (Bhuyan & Uddin, 2010).

However, economic factors like rapid urbanization, market liberalization and income growth has introduced processed and fast food that caused major changes in the traditional dietary habit. According to Reardon et al (2014), 70% of the overall share of food purchase of urban dwellers in Asia consisted of processed food and for the rural people that share was alarmingly 59%. However, the striking change in diet is that it is more inclined to Western diets. The trend is replacing staples food with more livestock, dairy products, fat, oils and fewer vegetables and fruits (Pingali, 2007).

In Bangladesh, expenditure on junk food had increased at a rate of 15.5% each year over the period of 2001 to 2010 (BBS 2011). Some social drivers are also contributing to the rapid

changes, such as urban-rural migration, women in the workforce and sedentary lifestyle. Commercial production and import was necessary to meet the booming demand for processed and fast food besides conventional production. A revolution of supermarket culture and the fast-food chain are overshadowing local traditional market with their exotic collection of products (Reardon et al., 2004). All of the above reason resulting in low intake of fruits and vegetables and also increasing the risk of NCDs in Bangladesh (WHO, 2011). Recent data reveals that the average per-capita daily fruit and vegetable consumption is approximately 211 grams, compared to the WHO/FAO's (2014) recommended minimum of 400 grams.

In terms of household expenditure, only 13% and 6% of total expenditure for food was allocated for purchasing vegetables and fruits (Awal, Sabur, and Mia, 2008). Similarly, the expenditure (income) elasticity of fruits and vegetables were 0.65 and 0.58, indicating that ten percent rise in expenditure would be accompanied with a rise in consumption by 6.5% and 5.8%, respectively. While it was believed prior to the 1990s that a rise in average income would accompany with an increase in fruit and vegetable consumption, empirical investigations have revealed that this relationship is not so straightforward at a disaggregated level, and that higher household income can sometimes be correlated with a higher consumption of rice and cereals but not fruit and vegetables (BBS, 2003; 2010).

Recognizing the urgency of promoting healthy diets to reduce the incidence of NCDs, the Government of Bangladesh endorsed strategies to substantially increase fruit and vegetable consumption in the country during 2007 (MHFW, 2010). To increase consumption, it is needed to increase the demand for fruits and vegetables. According to theories of economics, own price, prices of related products and per capita income are among the major elements for determining the demand for any commodity (Tey et al., 2009). It is therefore necessary to determine the changes in demand for different food categories such as vegetable, fruits, rice, pulses and wheat products, fish and meat, milk, milk products and spices in response to income and price changes. In order to gain insights about the response of expenditure elasticity and price elasticity in both urban and rural communities of Bangladesh, the present study considered the demand for the aforementioned seven food groups.

The objective of the current study was to understand how demand elasticities for different food groups such as vegetables, fruit, rice, pulses, wheat products, fish, meat, and dairy products

changes according to consumers' income (i.e., income effect) commodity prices (i.e., price effect) and place of residence. Such a disaggregated demand analysis is essential for formulating effective policies to promote fruits and vegetable consumption.

2.2 Literature Review

The consumer demand systems of LMICs usually have lower purchasing power with an inclined preference for traditional ethnic foods (Makweba, 2009). Despite this established norm, markets for foods are changing and mostly motivated by urbanization and rise of middle class across all LMICs. Demand for food shifted more towards western and expensive food but not necessarily nutritional ones (Behrman and Deolalikar, 1987; Popkin, 1994). This 'nutrition transition' towards more fat and sugar rich diet and less fruit and vegetable consumption is a leading cause for health concern globally. Thus the search for scientific linkages between diet and human health is relentless (Meng et al., 2013).

Demand for a particular food commodity can be analyzed using economic factors such as own price, income, price of other goods and some social factors (Koutsoyiannis, 1980). Most published literature has looked into aggregated food demand with a focus on economic factors like income and price (Talukder, 1990; Islam et al., 2007). In Bangladesh, most prior food demand research focused mainly on aggregated food items or rice and wheat, with only a handful tackling demand and price elasticity for fruit and vegetables and almost no investigation pursued at a commodity level (e.g., Cabbage, Cauliflower, Mango, Banana). A review of the most commonly cited food demand studies conducted in Bangladesh (Goletti, 1993; Ahmed and Shams, 1994; Talukder, 1990; Khanam and Ferdous, 2000; Mullah 2005) revealed that the most widely used data source was the national level Household Income and Expenditure Survey (HIES) and the most commonly-used theoretical model was a linear approximation of Almost Ideal Demand System (LA/AIDS).

A few studies applied the Frisch method (Chowdhury, 1982) wherein a consumers' preference is considered an independent choice if the marginal utility of the product is dependent on quantity of that good only. In contrast to Frisch method, the Food Characteristics Demand System (FCDS) method reveals whether marginal utility of a good dependent on consumption of all the other goods (Bouis, 1989; 1996). Other relevant studies applied the Tobit method for determining the food demand (Pitt, 1983; Goletti, 1993). However, the Frisch and FCDS methods

have been criticized for being overly restrictive and the Tobit model for not counting zero value observations. These shortcomings were addressed in the AIDS model developed by Deaton and Muellbauer (1980).

This model was first applied to Bangladesh by Ahmed and Shams (1994), who in the early 1990s analyzed primary survey data collected in three Districts (second tier administrative units). Their study recorded significant change in price elasticities in low income households. Despite considerable monthly household income disparities between urban (US \$266) and rural (US \$158) areas in Bangladesh, only a handful of studies considered rural-urban variations in income and expenditure elasticities (BBS, 2019). One among these was conducted by Hossain and Yunus (2016), who applied the AIDS model to estimate urban-rural income elasticity; they found that irrespective of income group, income elasticity of staples was higher among rural households than urban households. Similarly, in India a study revealed that income elasticity varies widely among different food groups, being lowest for rice and cereal groups and highest for livestock, fruit, and vegetables (Kumar et al., 2011). The study further indicated that a price increase would more adversely affect demand for non-staple (meat, fruit, and vegetables) food than staple (rice, flour, wheat, sugar) food.

However, linear AIDS models are incapable of capturing the non-linearity in consumption patterns. Thus, a demand study used the Quadratic AIDS (QUAIDS) model in South Africa and determined that demand behaviour differs between geographical areas and income groups (Bopape & Myers, 2007). Average expenditure share in fruit and vegetables was lower in urban areas (0.17) and higher income (0.16) groups than the rural and lower or middle-income groups (0.18). Unlike in South Africa, the QUAIDS revealed that in Nigeria expenditure on fruit and vegetables was higher among urban dwellers, and the males and the elderly were less into fruit and vegetables (Ogundari et al., 2013).

Studies in several countries have revealed that fruit and vegetables are considered a luxury good (Ogundari et al., 2013; Cupak et al., 2015). A research in Slovakia showed that expenditure elasticity for fruit and vegetables (1.77) was higher than meat (0.99), indicating that these food groups were luxuries. However, Awal, Sabur, and Mia (2008) pursued a year-long (2007-2008) primary survey data to estimate vegetable demand elasticity that determined vegetables to be an inelastic good.

The majority of existing studies on food demand in Bangladesh have used secondary data from the HIES and used the linear AIDS model to estimate demand elasticities. As these linear models are incapable of capturing the non-linearity in consumption patterns, a clear perspective is unattainable. In addition, significant gaps remain in our understanding of the effects of gender or urban –rural groups on expenditure patterns.

The present study endeavors to fill some of the gaps by estimating income (expenditure) and price elasticities for seven aggregated food categories: vegetables, fruit, rice, pulses, fish and meat, milk, and spices. The study also investigates food and non-food budget share of households, detailed income (expenditure) elasticities of disaggregated fruits and vegetables in the context of rural Sylhet and urban Dhaka. Due to its numerous advantages over older linear models, the quadratic demand system – commonly known as the QUAIDS model – is used in this research. Details of QUAIDS model are described in Section 2.4.

2.3 Methodology

2.3.1 Study Area and Sampling Procedure

In Bangladesh, household income and food consumption patterns vary significantly between urban and rural areas, as do livelihood occupations and lifestyles. Therefore, the present study was carried out in both the capital city of Dhaka South and the (rural) Sylhet Division in the northeast region of the country.

The sample respondents for the urban component of the study were selected from four Wards (new Ward number 1, 11, 40, 41) of the City Corporation of Dhaka South. In order to capture the required diversity, the rural sample respondents were selected from Borolekha and Kamolgonj *Upazila* (third-tier administrative units) in Maulovibazar District and Derai *Upazila* in Sunamganj District, Sylhet Division.

A total of 501 households - 200 urban and 301 rural - were selected for the study using a simple random sampling procedure. The distribution of the sampling units (households) was selected using the probability proportional to size (PPS) sampling method. The final stage of the sampling procedure involved a stratified sampling strategy (Thompson, 2012) based on the wealth

and socioeconomic status of each household, using baseline data from the previously-conducted IDRC² project surveys. The respondents from each wealth and socioeconomic stratum within each *Upazila* were then selected randomly.

2.3.2 Household Survey

The required household survey data were collected from 200 urban households in the City of Dhaka South and 301 rural households in Sylhet Division. Only the household head (both male and female) or the lead women of each household were surveyed. The survey instruments sought to determine patterns of fruit and vegetable consumption, expenditure on fruit and vegetable, economic and non-economic characteristics of each household. Questions also sought to determine eating habits from the last 24 hours, consumption frequency for various food types, and smoking habits. A detailed expenditure survey was conducted to collect information on monthly consumption on food and non-food items in a total of 211 households (70 urban and 141 rural).

2.3.3 Selection of food items

Yearly consumption data collected using the survey questionnaires were converted into monthly figures and verified through comparison with local market prices. Reported food items were grouped into one of seven categories: vegetables, fruit, rice, pulses and wheat products, fish and meat, dairy products, and spices.

2.3.4 Analytical model specification

The objective of the study focused on demand analysis for fruit and vegetables using price and income (expenditure) elasticities. The usual theoretical model used for the analysis is the AIDS model (Deaton and Muellbauer, 1980). Another group of researcher generalized the linear AIDS model by including a quadratic expenditure term to incorporate a non-linear Engel's curve (Banks,

² This research was conducted under the International Development Research Centre (IDRC), Canada-sponsored international collaborative project on *Reducing dietary-related risks associated with non-communicable diseases (NCDs) in Bangladesh*, which used multiple criteria to select the the City of Dhaka South for its urban component and the Districts of Moulovibazar and Sunamgnaj of Sylhet Division for the rural component.

Blundell, and Lewbel, 1997). The model in that analysis was called the Quadratic Almost Ideal Demand System (QUAIDS). This model does not require any direct utility function, instead using a price and household expenditure function as the main component of an indirect utility function.

$$\ln V = \left\{ \left[\frac{\ln m - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1} \quad (1)$$

In the above equation, $\ln V$ is the indirect utility function, m is the household expenditure, k is number of food categories, and $\ln a(p)$ is a logarithmic function of price vector p ,

$$\ln a(p) = a_0 + \sum_{i=1}^k a_i \ln p_i + \frac{1}{2} \sum_{i=1}^k \sum_{j=1}^k \gamma_{ij} \ln p_i \ln p_j \quad (2)$$

$b(p)$ represents the price aggregator derived from Cobb-Douglas function,

$$b(p) = \prod_{i=1}^k p_i^{\beta_i}$$

and

$$\lambda(p) = \sum_{i=1}^k \lambda_i \ln p_i$$

The requirements imposed on the QUAIDS equations are adding up; homogeneity and Slutsky symmetry conditions shown as below,

$$\sum_{i=1}^k a_i = 1, \sum_{i=1}^k \beta_i = 0, \sum_{i=1}^k \lambda_i = 0, \sum_{j=1}^k \gamma_{ij} = 0 \text{ and } \gamma_{ij} = \gamma_{ji}$$

If a household's consumption of good i is denoted by q_i , then its expenditure share is $w_i = p_i q_i / m$.

After introducing Roy's identity, the expenditure share becomes:

$$w_i = a_i + \sum_{j=1}^k \gamma_{ij} \ln p_j + \beta_i \ln \left\{ \frac{m}{a(p)} \right\} + \frac{\lambda_i}{b(p)} \left[\ln \left\{ \frac{m}{a(p)} \right\} \right]^2 \quad i=1, \dots, k$$

Apart from economic variables such as price and income, the QUAIDS model allows for sociodemographic variables affecting demand such as household size, composition, and location. Our model incorporated the sex of the head of each household, adult equivalents (AE), and geographical location (rural or urban). The *quaid*s command in STATA incorporates demographic

information in the vector of household characteristics z (Ray, 1983; Poi, 2002). With this modification, the expenditure share equation for good i become:

$$w_i = \alpha_i + \sum_{j=1}^k \gamma_{ij} \ln p_j + (\beta_i + \eta_i z) \ln \left\{ \frac{m}{m_0(z)a(p)} \right\} + \frac{\lambda_i}{b(p)c(p,z)} \left[\ln \left\{ \frac{m}{m_0(z)a(p)} \right\} \right]^2 \quad (3)$$

$$\text{where } c(p, z) = \prod_{j=1}^k p_j^{\eta_j z}$$

From model (3), Poi (2002) derived uncompensated price elasticity of the i^{th} good with respect to price change in good j as: $\epsilon_{ij} = -\delta_{ij} + \frac{1}{w_i} (\gamma_{ij} - \left[\beta_i + \eta_i z + \frac{2\lambda_i}{b(p)c(p,z)} \ln \left\{ \frac{m}{m_0(z)a(p)} \right\} \right] \times (\alpha_j + \sum_{l=1}^k \gamma_{jl} \ln p_l) - \frac{(\beta_j + \eta_j z)\lambda_i}{b(p)c(p,z)} \left[\ln \left\{ \frac{m}{m_0(z)a(p)} \right\} \right]^2)$

Moreover, the expenditure (income) elasticity for good i is

$$\mu_i = 1 + \frac{1}{w_i} \left[\beta_i + \eta_i z + \frac{2\lambda_i}{b(p)c(p,z)} \ln \left\{ \frac{m}{m_0(z)a(p)} \right\} \right]$$

The Slutsky equation then gives the compensated price elasticity as $\epsilon_{ij}^c = \epsilon_{ij} + \mu_i w_j$

2.3.5 Estimation

We used the statistical software STATA and its *quads* commands for our analysis. This command works on an AIDS model whether it has a quadratic term or not, and enables the post-estimation computation of expenditure elasticities and price elasticities (Poi, 2012). This model helped to explain the amount of expenditure on fruit and vegetables with regard to total household expenditures, the price of a particular commodity, or any other economic and non-economic characteristics of each household (e.g. sex of the head of the household, geographical location etc.).

All disaggregated food expenditures were calculated using the adult equivalence method before the final estimation. The adult equivalence consumption unit was calculated using Ahmed and Shams' (1994) method that used in the IFPRI study. Adult equivalence reflects that differently-aged members of the same household may not consume the same amount or types of food at the same time. Thus, per capita expenditure in all food items was converted to adult equivalent expenditure, and family size was converted to adult equivalent family size. After adjusting for the

adult equivalence, the produced results were charted according to geographical location and income group.

2.4 Empirical Results

2.4.1 Descriptive statistics

Summary data on the socio-demographic conditions of the two study areas are presented in Table 2.1. Of the 501 household heads interviewed, 379 (75.7%) were male and 122 (24.3%) were female. There were more female household heads in urban areas (32%) than rural areas (19%). The mean age was 49 years for both male and female heads. In rural areas, more than 50% of the participants had no formal schooling, one third went to primary schools, and less than 2% attained higher secondary or post-secondary education. Conversely, in urban areas more than 50% of participants had completed their primary or secondary education, and 37% secondary or post-secondary education.

Table 2.1 : Socio-demographic profile of the participants (%)

	Rural (60%)	Urban (40%)	Total (100%)
N	301	200	501
Age			
25-34	16.0	13.5	15.0
35-44	21.9	21.0	21.6
45-55	25.6	25.0	25.4
55-64	21.3	23.5	22.2
65+	15.3	17.0	16.0
Household head			
Male	80.7	68.0	75.7
Female	19.3	32.0	24.3
Education			

No formal	54.8	11.0	37.3
Primary	32.2	25.0	29.3
Secondary	11.3	27.0	17.6
Higher Secondary	1.0	13.0	5.8
Graduate	0.7	24.0	10.0
HH monthly Income (in BDT)			
Low Income: <15000	81.8	19.1	58.6
Moderate income: 15001-30000	14.9	33.5	21.8
Moderate to higher income: 30,000 +	3.4	47.4	19.6
Total	100.0	100.0	100.0

The majority of surveyed households (82%) in rural areas earned less than BDT 15,000 (US \$ 177.5) per month, with only 3.4 % earning more than 30,000 BDT (US \$355). However, the majority of the participants (47.4%) living in urban areas earned more than 30,000 BDT (US \$355) per month.

Data on average household budget share by geographic area and gender are shown in Table 2.2. In rural areas, budget share for food expenditure was higher than non-food expenditure. Female-headed households were 6% more likely to spend money on non-food items than male-headed households. Average expenditure on major foods item such as vegetables (4%), fruit (4%), fish and meat (12%) were similar in both male and female-headed households. However, female-headed households spent 13% of their total budget on rice while male-headed households spent 17%.

Table 2. 2: Average monthly expenditure (in BDT) and budget share by area and gender

	Rural				Urban				Total			
	Male	%	Female	%	Male	%	Female	%	Male	%	Female	%
n	117		24		46		24		163		48	
Vegetables	478	4.0	468	3.0	1277	4.0	1351	4.0	704	4.0	910	4.0
Rice	2033	17.0	1875	13.0	1641	5.0	1669	5.0	1922	11.0	1772	8.0
Pulse/cereal	279	2.0	282	2.0	488	2.0	527	2.0	338	2.0	404	2.0
Spice	753	6.0	854	6.0	1345	4.0	1288	4.0	920	5.0	1071	5.0

Milk	474	4.0	544	4.0	966	3.0	1266	4.0	613	4.0	905	4.0
Fruit	515	4.0	497	4.0	1635	5.0	879	3.0	831	5.0	688	3.0
Fish and Meat	1434	12.0	1724	12.0	4857	16.0	4895	15.0	2400	14.0	3309	14.0
Tobacco	856	7.0	908	7.0	1028	3.0	510	2.0	904	5.0	709	3.0
Miscellaneous	38	0.0	10	0.0	35	0.0	15	0.0	37	0.0	12	0.0
Dine out	128	1.0	55	0.0	346	1.0	165	1.0	189	1.0	110	0.0
Food	6986	58.0	7218	52.0	13618	45.0	12564	39.0	8858	52.0	9891	43.0
Non-food	5013	42.0	6695	48.0	16441	55.0	19421	61.0	8238	48.0	13058	57.0
Total	11999	100	13913	100	30058	100	31985	100	17095	100	22949	100

In urban areas, expenditure on non-food items was higher than on food items. Similar to in rural areas, female-headed households in urban areas were slightly (6%) more likely to spend money on non-food items. Expenditure on major food items such as fruit (4%), vegetables (4%), rice (5%), and fish and meat (14-15%) were similar for both kinds of households.

In the overall sample, 49% of entire household expenditure was spent on food, of which 4% was spent on fruit and vegetables. Even though the percentage was similar in both areas, the actual expenditure was three times higher in the urban areas. The budget share for rice seemed to be very low in urban areas (5%) compared to rural (15%) areas, while the greatest amount was spent on fish and meat in both areas.

In each interview, the head of the household was asked how much they spent on fruit and vegetables per month. As shown in Table 2.3, expenditure patterns varied widely between rural and urban areas but not male and female-headed households.

Table 2. 3: Distribution of monthly fruit and vegetable expenditure in BDT by demographic characteristics

	Rural (n = 141)		Urban (n = 70)	
	Male	Female	Male	Female
N	117	24	46	24
Mean expenditure on fruit and vegetables (in BDT)	993	965	2,276	2,229

Age of household head				
25-34	772	793	1,611	3,094
35-44	965	1,120	2,174	2,059
45-55	1,067	933	2,618	1,989
55-64	948	920	2,156	2,399
65+	1,131	1,186	2,909	2,181
Education of household head				
No formal education	974	868	1,324	1,584
Primary	1,047	1,325	2,707	2,792
Secondary	922	452	2,313	2,362
Higher Secondary	1,386	-	2,416	1,492
Graduate	--	-	2,797	2,196
Household Income (in BDT)				
<10,000	706	863	2,094	2,135
10,001-20,000	1,418	1,139	1,232	2,138
20,001-3,0000	1,106	833	2,318	1,545
30,001-50,000	1,729	-	2,864	3,221
50,001>		917	2,944	2,132
Presence of children				
Children (under 5 years)	1,049	966	3,559	2,604
No children	941	965	2,366	2,131
Occupation of household head				
Day labour	742	1,553	1,496	2,343
Self employed	1,138		1,773	
Agriculture	1,059		-	
Business	1,403	1,130	2,487	2,317
Service	1,308		1,969	2,121
Housewife		880		2,055
No Occupation/ Retired	1,140	1,100	2,686	2,285

A decreasing trend in expenditure on fruit and vegetables was significant among people aged 25-34 in both urban and rural areas, while those aged 65 and over spent more on these than all other groups. This may be because said respondents were retired and receiving money from children and grandchildren living in the same household or abroad.

Household heads who had no formal education spent the least on fruit and vegetables in both areas. In rural areas household heads who had primary education spent more on fruit and vegetables than the higher-educated, whereas in urban areas the opposite occurred. In urban areas, the educated household heads were spending more on fruit and vegetables. Educated male and female-headed households spent about the same on fruit and vegetables.

The presence of children under five years of age consistently increased spending on fruit and vegetables irrespective of region. However, the impact of household income on fruit and vegetable expenditure did not exhibit a clear pattern, though households in urban areas spent almost 3 times more on fruit and vegetables than their rural counterpart.

Analysis of the employment status of respondents revealed that those work in the business and service sectors were more into buying fruit and vegetables in both areas. Women spent about the same on fruit and vegetables irrespective of occupation.

2.4.2 Elasticity estimates from QUAIDS Model

According to the permanent income hypothesis (Friedman & NBER, 1957), expenditure is more predictive of consumer behavior than income. With this in mind, data on the income (expenditure) elasticity of seven food groups are presented in Table 2.4. Although the survey collected the real income of each household, expenditure is used for all calculations.

Table 2. 4: Income (Expenditure) elasticity of demand

Item	Rural	Urban	Total
Vegetables	1.017969	0.9387858	0.9917017
Cabbage	0.973713	0.859722	0.934812
Cauliflower	0.986205	0.924717	0.965221
Bottle Gourd	0.943343	1.170363	1.020818
Bitter Gourd	1.313874	1.044789	1.222043

Brinjal	0.797207	1.129482	0.917767
Tomato	1.064448	1.057387	1.062038
Stem Amarnath	1.105442	0.965479	1.057677
Indian Spinach	0.978388	0.778627	0.910215
Eddoe	1.065474	0.427662	0.847808
Green Papaya	0.985541	0.928951	0.966229
Fruit	1.187742	1.157439	1.177689
Lime	0.541053	0.678325	0.590169
Jackfruit	0.989881	0.217906	0.71367
Guava	1.310236	1.262924	1.293308
Lychee	1.103576	0.865581	1.018422
Pineapple	1.059536	0.543323	0.874836
Mango	1.045973	0.710818	0.926055
Banana	0.836977	-0.12401	0.49314
Rice	0.8127562	0.1529547	0.5938797
Pulses and other	0.9541306	0.9344598	0.9476052
Fish and Meat	1.091444	1.062203	1.081744
Milk	1.226525	1.075535	1.176436
Spice	0.802507	0.8156091	0.8068534

Income (expenditure) elasticity reveals the percentage change in the quantity demanded when income changes by 1%. The sign and the magnitude of the elasticity determine if the product is a normal, necessary, luxury, or inferior good. On average, all the food items included in Table 4 exhibit positive income elasticity implying all goods were considered normal (except bananas in the urban area). However, fish and meat, milk, vegetables, and fruit were elastic (magnitude more than 1) and were thus considered as luxury. Rice, pulses and spices were found to be inelastic meaning these were necessary (staple) goods. Income (expenditure) elasticity for vegetables, fruit, rice, pulses, fish, meat, and milk were higher in rural areas. By contrast, only spices had higher income elasticity in urban areas.

Larger income (expenditure) elasticity means higher income will induce higher consumption of the respective products. The data indicated that urban dwellers were slightly more likely to buy more spices when they had more income in hand than their rural counterparts. Presently, a rapidly expanding restaurant industry is one factor contributing to urban people having

more access to imported spices. Moreover, vegetables appeared to be inelastic in urban areas as there are more and better sources of fresh vegetables (e.g. supermarkets, grocery supply chains, wholesale markets) there than in rural areas. The only item which exhibited a major discrepancy in income (expenditure) elasticity between urban and rural areas was rice, which is more widely eaten (and thus more inelastic) in rural areas. However, the expenditure elasticity of all major food products was higher in rural. That fish, meat, and milk exhibited the highest expenditure elasticity suggested that an increase in average household income had shifted diets towards greater protein intake.

Table 2. 5: Own price elasticity

Items	Rural		Urban		Total	
	Uncompensated	Compensated	Uncompensated	Compensated	Uncompensated	Compensated
Vegetables	-1.0842275	-0.8688628	-1.035063	-0.7604805	-1.0708648	-0.833178
Fruit	-0.9222395	-0.6708988	-0.8524873	-0.6231823	-0.906824	-0.6666806
Rice	-0.9978696	-0.7916466	-0.9029422	-0.8456004	-0.977358	-0.8219162
Pulses	-1.3296451	-1.3011491	-1.3137166	-1.2841831	-1.3242134	-1.295369
Fish and meat	-0.8893886	-0.7199651	-0.8847285	-0.601984	-0.8910473	-0.6811592
Milk	-0.6667254	-0.6098619	-0.673763	-0.6155341	-0.6700102	-0.6123095
Spices	-0.5116465	-0.4393579	-0.4789908	-0.410727	-0.501683	-0.4313883

The price elasticity of the seven selected commodities is shown in table 2.5, for both areas. The own-price elasticity of demand is the measurement of change in quantity demanded of a product in relation to a change in price of that product. The own-price elasticity of commodities (except Giffen goods) typically has a negative sign. According to economic theory, demand for a good will be decreased, when the price increases, hence the negative sign. An elasticity magnitude greater than 1 suggests an elastic good, and a magnitude less than 1 an inelastic good. Uncompensated own-price elasticity measures the responsiveness to a change of quantity demanded (holding income constant) when the price changes, holding income constant. The compensated own-price elasticity deals with fragment of total change in quantity demanded that is purely due to changes in relative prices (holding real income constant). Whereas uncompensated

price elasticity captures the substitution as well as the income effect of a price change, compensated price elasticity captures the substitution effect only. Hence, the absolute value of compensated price elasticity is lower than that for uncompensated price elasticity for normal goods (and vice-versa for inferior goods).

In table 2.5, comparison of compensated and uncompensated price elasticities suggests that households were fairly adjusting to fluctuations in price by either reducing or increasing consumption of the respective goods. However, rural consumers were more responsive to price changes for rice, vegetables, fruit, fish, and meat, while urban consumers were more sensitive to price changes for vegetables, fruit, fish, and meat. There was also a significant price effect on rice in rural but not urban areas. In comparison to the rural counterpart, price changes for vegetables also had a notably higher effect in urban areas. The price effect was higher for fish and meat (more in the urban areas) than other food items. Vegetables had higher effect due its larger proportion in the total expenditure in both areas. The price change had minimal effect on these food items representing a small share of household expenditure.

Table 2. 6: Uncompensated Cross price elasticity

Price of	Demand for						
	Vegetables	Fruit	Rice	Pulses	Fish and Meat	Milk	Spice
	Total						
Vegetables	-1.0708648	0.0422696	0.0104495	0.0481173	-0.0295206	0.0449551	0.0608202
Fruit	0.0224222	-0.906824	0.0234691	-0.0295788	-0.0453821	0.0571001	0.1370392
Rice	0.047568	0.0947363	-0.977358	0.0484272	-0.0115046	0.0399716	0.0548331
pulses	0.3865567	0.1775373	0.2857412	-1.3242134	-0.0402565	0.1395807	0.0397571
Fish and Meat	-0.0503033	0.0408536	0.0767359	-0.0102052	-0.8910473	0.0055525	0.0358917
Milk	0.1804654	0.2288152	0.2200319	-0.0846613	0.0167415	0.6700102	0.1091434

Spice	-0.1052002	0.2677956 ⁻	0.1196449	0.0184683	-0.0202628	0.0483504 ⁻	-0.501683
Rural							
Vegetables	-1.0842275	0.0594011	0.0101449	0.0531945	-0.0455972	0.0480492	0.0606811 ⁻
Fruit	0.029253	0.9222395 ⁻	0.0041708 ⁻	-0.0295736	-0.0271288	0.0550148 ⁻	0.1374744 ⁻
Rice	0.0460669	0.0597399	0.9978696 ⁻	0.0385021	3.047E-05	0.0309926 ⁻	0.036353
pulses	0.3938024	-0.183423	0.2887594	-1.3296451	-0.0401938	0.1415203 ⁻	0.0387753
Fish and Meat	-0.07438	0.0215117 ⁻	0.0569623 ⁻	-0.0106478	-0.8893886	0.0046933	-0.031118
Milk	0.1783316	0.2258698 ⁻	0.2118734 ⁻	-0.0850296	0.0093014	0.6667254 ⁻	-0.109087
Spice	-0.0989657	0.2676288 ⁻	0.1077488	0.0175493	-0.0122692	0.0472348 ⁻	0.5116465 ⁻
Urban							
Vegetables	-1.035063	0.0067675	0.0343795 ⁻	0.0410882	0.0067437	0.0429191	0.0606027 ⁻
Fruit	-0.0241855	0.8524873 ⁻	0.0688195	-0.0318096	-0.1096432	0.0681546 ⁻	0.1352464 ⁻
Rice	0.0515432	0.243205	0.9029422 ⁻	0.0923007	-0.0622577	0.0807546 ⁻	0.1301255
Pulses	0.3747372	0.1687699 ⁻	0.2792484	-1.3137166	-0.0384348	0.1353935 ⁻	0.0407215
Fish and Meat	-0.0085019	0.0689617 ⁻	0.0894485 ⁻	-0.0085602	-0.8847285	0.0090381	0.0395511 ⁻
Milk	0.1975272	0.2435765 ⁻	0.2305125 ⁻	-0.0830827	0.0412312	-0.673763	-0.110145
Spice	-0.1333597	0.2572375 ⁻	0.1395777	0.0194766	-0.0489706	-0.053809	0.4789908 ⁻

The uncompensated cross-price elasticity (UCPE) of demand for the seven categories of foods in the study areas is shown in Table 2.6. This type of price elasticity determines the change

in the quantity demand for a product to the price change of another product. Uncompensated price elasticity measures gross effects of both income effects and substitution effects. When the cross-price elasticity is positive, it denotes that two goods are substitutes for each other and negative cross-price elasticity denotes the goods are gross complements.

Fish and meat exhibited a complementary relationship with vegetables and rice. When the price of fish and meat falls by 10%, the demand for vegetables increased by 0.5% and for rice by 0.7%. This is explained by the fact that in Bangladeshi cuisine, very few fish and meat curries are cooked without vegetables. However, a 10% fall in fish and meat prices increases rice consumption by 0.7% nationally, indicating that rice is still the prevalent staple. Pulses exhibited a positive relationship (substitute) with vegetables, with a 10% rise in vegetable price increasing the demand for pulses by 3.9%. This also makes sense as pulses are a staple of Bangladeshi cuisine and an inexpensive source of protein. However, the magnitude of this cross elasticity is too small to have a strong price effect, suggesting that a price intervention might not have a significant impact on the economy.

Table 2. 7: Compensated Cross price elasticity

Price of	Demand for						
	Vegetables	Fruit	Rice	Pulses	Fish and Meat	Milk	Spice
	Total						
Vegetables	-0.833178	0.2624966	0.1952094	0.0789485	0.1683083	0.0985619	0.0296533
Fruit	0.2816044	- 0.6666806	0.2477269	0.0040407	0.1703376	0.0013546	- 0.0383836
Rice	0.2272173	0.261189	- 0.8219162	0.0717301	0.1380192	0.0005456	0.1232151
pulses	0.608927	0.0284983	0.4781474	-1.295369	0.1448243	- 0.0894283	0.1244004
Fish and Meat	0.2018724	0.192798	0.1414595	0.0225054	-0.6811592	0.0624271	0.0600968
Milk	0.4363041	0.0082302	0.0013329	-0.0514756	0.2296784	- 0.6123095	- 0.0117606

Spice	0.0794741	-0.096687	0.2794347	0.042423	0.1334433	-	-
						0.0066998	0.4313883
Rural							
Vegetables	-0.8688628	0.2829772	0.2580774	0.083045	0.1144709	0.1002429	0.0300496
Fruit	0.2713625	-	0.274551	0.0039839	0.1528172	0.0036605	-
		0.6708988					0.0354763
Rice	0.2252009	0.2457039	-	0.0633308	0.1331704	0.0124206	0.1118201
			0.7916466				
pulses	0.5993946	0.030008	0.5254416	-1.3011491	0.112611	-0.091695	0.125389
Fish and Meat	0.153572	0.2151316	0.2054609	0.0209474	-0.7199651	0.0599375	0.0649156
Milk	0.4129654	0.0177101	0.0582421	-0.0525083	0.1836911	-	-
						0.6098619	0.0102385
Spice	0.0726236	-	0.3052861	0.0413324	0.1152631	-	-
		0.0894972				0.0056501	0.4393579
Urban							
Vegetables	-0.7604805	0.2121654	0.0775894	0.0727999	0.2744044	0.0974611	0.0260603
Fruit	0.2823569	-	0.1938209	0.0035931	0.1891718	-	-
		0.6231823				0.0072642	0.0384963
Rice	0.1921631	0.3483939	-	0.108541	0.0748173	-	0.1745076
			0.8456004			0.0528224	
pulses	0.63046	0.0225202	0.3835267	-1.2841831	0.2108417	-	0.1214321
						0.0845977	
Fish and Meat	0.2815545	0.1480112	0.0288302	0.0249385	-0.601984	0.0666538	0.0519957
Milk	0.4906704	-	-0.110975	-0.0492275	0.3269847	-	-
		0.0242946				0.6155341	0.0176239
Spice	0.0829268	-	0.2277747	0.0444556	0.1618637	-	-0.410727
		0.0954471				0.0108466	

The compensated cross-price elasticity (CCPE) of demand for the seven food categories in the study areas is presented in Table 2.7. This type of price elasticity measures the substitution effect of price fluctuation. This is also known as the net effects of price change or pure price effect. Similar to the uncompensated price elasticity of demand, positive cross price elasticity denotes that two goods are net substitutes and when the cross price elasticity is negative, it indicates that the goods are complements.

Vegetables, pulses, fish, and meat were positively related, indicating that they were substitute goods. A 10% increase in fish and meat price raised demand for pulses by 0.22%. A more fitted substitute for fish and meat was vegetables with a CCPE of 0.20, meaning that an increase in the price of fish and meat by 10% would increase the consumption of vegetables by 2.0%. However, substitutability between vegetables and fish and meat was more prominent in urban (0.28) than in rural areas (0.15)

Several cross-price elasticities altered their (negative/positive) signs between their compensated and uncompensated figures. For example, the UCPE of fish and meat was negatively related with vegetables, making them gross complements (Table 2.6), while the CCPE of the same two items were positively related, indicating they were net substitutes (Table 2.7). However, in table 4, income elasticity was higher for fish and meat (1.08) than vegetables (0.99). A strong income effect (overshadowing substitution effects) suggests that the rise in real income increases the demand for vegetables. A fall in the price of fish and meat causes the real income to rise. However, when considering pure price effect, the fall in fish and meat prices actually decreased the demand for vegetables.

2.5 Discussion and conclusion

In order to lower incidences of non-communicable diseases (NCD), it is vital to increase consumption of fruit and vegetables to recommended levels. The purpose of this study was to explore potential economic (income, price) drivers of fruit and vegetable consumption in Bangladesh.

Sociodemographic descriptive investigation revealed the expected pattern that 80% of the studied households were male-headed, living in rural areas with no formal education (55%) and earning a low monthly income (<15000 BDT). Participants in urban areas were more educated and largely belonged to moderate-to-high income groups.

A survey study of 550 households in Bangladesh by Awal, Sabur, and Mia (2008) found that more than 85% of total expenditure was spent on food and rural people spent more on non-food expenditures than their urban counterparts. In contrast, the present study found nonfood expenditure (57%) was higher than food expenditure (43%). With rising GDP, poor households had gained access to more non-food items than ever before. However, the basic requirements of

food expenditure were still higher (52% compared to 39%) in rural areas, following the Engels law of consumption. The law states that as their income rises, households tend to spend proportionately less on essential food products. The budget share for fruit, vegetables, fish and meat was similar irrespective of geographic region and sex of the household head. Spending on fruit and vegetables varied randomly with rising income in both areas.

The influence of age on the consumption of fruit and vegetables was somewhat inconsistent with the literature. The study revealed that 25-34 years age group had less interest in eating fruits and vegetables except for the young urban women. In most countries, the 18-25 years age group is considered the most vulnerable group for unhealthy lifestyle and obesity (Jekielek and Brown, 2005). Other studies showed that the middle-aged, the elderly, and women were more concerned about eating fruit and vegetables but in the current study men were more into consuming healthy food (Dean et al., 2009; Martikainen et al., 2003)

The findings of the present study also revealed that spending on fruit and vegetables increased with education in both areas. Similar to other studies (e.g. Karim et al, 2017), wealth and education were positively associated with increased consumption of fruits and vegetables. Men's higher education, however, did not show any association with any dietary habits (Papier et al., 2017). Education is supposed to enhance nutritional knowledge and promote healthier eating habits; however, in the present study female-headed households with a post-secondary education tended to spend less on fruit and vegetable compare to male-headed households. The most likely reason for this was that the female household heads did not have a wage-earning job of their own. Mahmud and Bidisha (2016), in their study on rural labor markets, observed that highly educated women could not find work as their expectations were not met by the existing job market.

A woman's decision-making power compared to that of men significantly improves the nutritional health of their children (Smith et al., 2003). Numerous studies in the LMICs claimed that women with a large share of assets are likely to increase the budget share for food, especially micronutrient-rich fruit and vegetables (Quisumbing, 2003). Female-headed households in Rwanda were found to allot a prominent share of their budget to buy healthy food than male-headed households (Ministry of Planning, 1988).

The analysis of the descriptive statistics revealed that expenditure on fruits and vegetables was not significant and almost similar between male- or female-headed households; however, it did differ significantly between rural and urban areas. We used the QUAIDS model to estimate the expenditure elasticity, own-price, and cross-price elasticities, of the seven designated food groups by geographical region. In this study, the income elasticity of vegetables (1.01 rural and 0.94 urban), fruit (1.18), fish and meat (1.08), milk (1.18) were found to be larger than unity which means they are elastic or luxury goods. Rice, pulses and spices were inelastic or necessary (staple) goods.

An attempt to examine demand elasticity in 114 countries showed that in low-income countries of Asia and Africa, the income elasticity of fruits and vegetables varied from 0.60 to 0.70 whereas in high-income countries, it ranged from 0.20 to 0.37 (Mueller et al., 2001). Nadeem and Akhter (1990) and Murshid et al. (2007) found the expenditure elasticity of vegetables in Bangladesh to be 1.2 (rural), 0.76 (urban) and 0.82 (rural), 0.77 (urban). The results of the present study conform to these findings, with a higher income increasing consumption of vegetables more in rural areas (1.01) than in urban areas (0.94). But an income increase also induced a greater demand for rice in rural (0.81) than urban (0.15) areas which offset the benefit of rising vegetable consumption (See Table 2.4). However, with an income rise, both urban and rural people spent more on fish and meat, fruit, and milk rather than on vegetables.

Larger income (expenditure) elasticity indicates that increasing income would induce more consumption of those goods. Hence, inexpensive vegetables like Eddoe become less desirable (expenditure elasticity 0.84) but expensive vegetables like cauliflower (0.96), bottle gourd (1.02) and tomato (1.06) become more desirable with an income rise (Table 2.4). In some LMICs, fruit intake was found to be significantly higher in rural areas in comparison to urban areas (Mayen et al., 2014). In the current study, expenditure elasticity of fruit was slightly higher in rural areas (rural 1.19, urban 1.16). Expensive fruits like Lychee and Mango were highly desired by rural people and slightly less by urban people with the sole exception of Bananas, which were found to be an inferior good with a negative elasticity in urban areas (Table 2.4).

The income (expenditure) elasticities for pulses, fruit, vegetables, meat and fish were slightly higher for rural than urban areas. In rural areas, households were fairly responsive to changes in prices for rice, vegetables, fruit, fish, and meat, while urban households were more

responsive to price changes for vegetables, fruit, fish, and meat. There was a significant price effect on rice in rural areas but not the urban areas.

Even though fish and meat exhibited a complementary relationship with vegetables in uncompensated cross price elasticity, they became substitutes according to compensated cross-price elasticity. This means that due to the pure substitution effect, demand for vegetables would decrease with a fall in the price of fish and meat. This indicates that vegetables were not a suitable substitute for fish and meat. There was an increase in fruit consumption in urban areas but only during the summer (Mango and Lychee) season. Rice consumption decreased in urban areas in comparison to rural areas but the increased demand for protein (fish and meat) appears to have countered any health benefits of reduced carbohydrate consumption. Unlike in high-income countries, the presence of female-headed households does not have a significant effect on healthy consumption.

By providing crucial information about price and income elasticities, the findings of this research is expected to help the formulation of effective plans in to foster fruit and vegetable consumption in Bangladesh. Further, our results will be useful for policy analysis by international organizations and monitoring of food security by the government. Greater income-generation opportunities and decision-making power to the female population could potentially change the dietary habit of the households. The differing price elasticities of foods in rural and urban areas indicates that the food demand system differs significantly between these two geographical and socioeconomic settings, a differential which requires acknowledgement and serious policy attention. As a LMIC, policymakers of Bangladesh have to work on two fronts: nutrition and food security. Food security of the country depends on the market other than their own production. Thus, keen attention needs to be given on food and price policy and promotion of increased fruit and vegetable consumption through social marketing campaign and interventions while accounting for different norms in rural-urban area and selectively targeting the low income population.

This thesis aimed to determine potential drivers, impediments, and means of increasing fruit and vegetable consumption in Bangladesh. Regarding barriers, we particularly focused on economic and the non-economic impediments. In the current chapter (Chapter 2), we examined the responsiveness of economic components such as the income elasticity and price elasticity of fruits and vegetables in rural and urban areas of Bangladesh. Our empirical investigation revealed

that, people living in rural and urban tend to spend more money on fish and meat rather than on fruits and vegetables as their income increased. In addition, increased income tends to result in increased demand for expensive fruits and vegetables, but not necessarily those with higher nutritional value. Expensive fruits like lychee and mango were highly desired by the rural respondents and slightly less so by the urban respondents; the exception to this trend was bananas, which were found to be an inferior good with negative expenditure elasticity in urban areas. Rural (slightly more) and urban households were quite adjusting to changes in prices for rice, vegetables, fruit, fish, and meat. However, a significant price effect was observed for rice in rural areas, but not in urban areas. In addition to economic determinants, fruit and vegetable consumption may also be influenced by non-economic factors. In the following chapter (Chapter 3), we attempt to identify the socioeconomic, demographic, and sociocultural (e.g., belief systems and behavioural practices) factors contributing to low fruit and vegetable consumption in Bangladesh.

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Chapter 3:

Low Daily Intake of Fruits and Vegetables in Rural and Urban Bangladesh: Influence of Socioeconomic and Demographic Factors, Social Food Beliefs and Behavioural Practices³

Abstract: Bangladesh is facing a large burden of non-communicable diseases. As a possible remedy, the WHO/FAO recommends consuming 400 g or five servings of fruits and vegetables every day; however, only a small proportion of the population practices this. The present study sets out to determine the sociodemographic factors that affect this low intake of fruits and vegetables, and the roles that beliefs and behavioural practices play in influencing food consumption. Logistic and ordered logistic regressions were used to identify what sociodemographic factors are significantly influencing fruit and vegetable intake, and to explain the role of social food beliefs. It was found that in Bangladesh 75% of urban and 92% of rural populations consume less than five servings a day. While gender was not found to be a significant factor, housewives appeared to be more at risk of a lower intake of fruits and vegetables. People with higher income, higher education, and who are older were all less likely to have problems with a low intake of fruits and vegetables. Higher education assisted in attaining positive beliefs and behavioural practices regarding food, while residing in a rural community was found to be a significant constraint.

Keywords: sociodemographic factors; low fruit and vegetable intake; beliefs and behavioural practices; Bangladesh

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3.1 Introduction

Around 41 million people die each year globally because of non-communicable diseases (NCDs), 77% of which occur in low and middle income countries (LMICs) (WHO, 2021). Numerous studies reveal that regular intake of adequate quantities of fruits and vegetables contribute to improved health and can create immunity against NCDs (Rolls et al., 2004). Food choices cannot include everything edible, but need to be healthy and should contain fruits and vegetables. In light of such findings, the WHO/FAO recommends a minimum 400 g (or five servings) of fruits and vegetables every day to curb NCDs (WHO/FAO, 2003). Worldwide, emphasis on fruit and vegetable consumption has increased noticeably in recent decades as part of efforts to reduce the number of deaths from NCDs.

Despite these recommendations and promotion by international agencies, people in many LMICs consume far less than the required five servings. For example, studies in Iran, Kenya and Tanzania respectively observed that 87.5%, 94% and 82% of adults eat less than five servings a day (Esteghamati et al., 2012; Msambichaka et al., 2018; Pengpid & Peltzer, 2018). However, no significant difference in fruit and vegetable consumption was observed between Iranian urban and rural residents. Research in Tanzania, Iran and Thailand found that rural inhabitants, the young and single, those with no income, people with high tobacco use and men were all more likely to have inadequate fruit and vegetable intake (Esteghamati et al., 2012; Msambichaka et al., 2018; Phulkerd et al., 2020). Urban Kenyan women who were less educated were also found to be at higher risk of inadequate fruit and vegetable intake (Msambichaka et al., 2018). As occupational category often matters in fruit and vegetable consumption, Thai people who worked in agriculture were more likely to eat more fruits and vegetables than those who owned businesses or worked as manual labourers in a private firm or a government agency (Phulkerd et al., 2020). Income is also an important determinant of fruit and vegetable intake; expenditure analysis in poor communities in South Africa showed spending \$71.4 and more on food monthly and having a private vehicle increased the likelihood respectively to 1.6 and 2.1 times more to consume two or more servings of fruits and vegetables than those who spent less on food or used public transport to go to stores (Okop et al., 2019).

It is obvious that hunger is the key driver for eating. However, dietary choices and preferences are not driven only by biological and nutritional needs, economic, physical, social and psychological components also play considerable roles in determining food choices (Bellisle, 2006; Nijhuis & Brouwer, 2020). Although numerous studies have explored the social determinants of healthy diets among people in high income countries, research on the determinants of healthy food choices in LMICs is still scarce (Di Noia & Byrd-Bredbenner, 2014; Ruel et al., 2005). For example, there are various social, geographic and cultural norms that people follow in considering food consumption. In general, the literature on what sociodemographic characteristics influence food knowledge, social beliefs and behavioural practices is scant globally, and is even rarer in the LMIC context. One such study, involving female Sudanese students at Ahfad University, found that most of them lacked adequate knowledge of nutrition, and 42.4% gained what knowledge they had from mass media (Elhassan et al., 2013). Another rare example of this research in the LMIC context, in South Africa, revealed that neither a positive attitude towards healthy eating nor level of education were associated with inadequate eating (Okop et al., 2019).

The kinds of attitudes that may influence eating behaviours has received some attention in the literature. The most popular models in this area of study are the Attitude-Social Influence-Efficacy and the Planned Behaviour models (Ajzen, 1991; De Vries & Backbier, 1994). According to the aforementioned models, three types of psychological factors tend to influence dietary-related behaviour: (i) attitudes, (ii) social influence and (iii) self-efficacy. Here, *attitude* is related to whether a person holds positive or negative outlook about fruit and vegetable intake; *social influence* refers to the conditions and supports in the surroundings in favour of or opposed to this particular eating behaviour; and *self-efficacy* implies the ability of a person to perform the desired behaviour. In many LMICs, food beliefs and taboos are prevalent and influence peoples' attitudes from generation to generation, mostly about appropriate eating during pregnancy and physical illness (Irudukunda, 2020). Another belief is regarding the social status of crops: low status (mostly indigenous) crops are often called 'poor man's crops', while high status, expensive crops are considered 'rich man's crops' (Keatinge et al., 2015)

The above overview of correlates of low fruit and vegetable consumption in various LMICs reveals several key sociodemographic and attitudinal factors. It is apparent that most correlates are

related to gender, residence, age, income, occupation and lifestyle. Like most LMICs, the population of Bangladesh is burdened with a very high proportion NCDs and associated fatalities. To develop effective interventions and further promote the consumption of fruits and vegetables in Bangladesh, a better understanding of the factors driving the low consumption of fruits and vegetables and the processes associated with taboos and beliefs influencing food choices is urgently needed.

In consideration of this backdrop, the specific objectives of this paper are, in relation to rural and urban Bangladesh to determine the sociodemographic factors affecting (i) low intake of fruits and vegetables, and (ii) the social beliefs and behavioural practices concerning low fruit and vegetable intake.

3.2 Methods and Materials

3.2.1 Study Area and Sampling

The study area in Bangladesh is divided into rural and urban components. In this country, 70% of the land (mainly rural) is devoted to agriculture (FAO, 2021). Rural population consists of 62% of the total population whereas the remaining (i.e., 38%) lives in the cities (The world Bank, 2019). In Bangladesh, the culture of collective living (joint family) and farming with a patriarchal rule of descent are prevalent. This is reflected in that only 15.8% of the households are female-headed (Demographic and Health Surveys, 2018). Collective or joint families consist of at least three generations (grandparent, parent, children) and the head of the household is usually the eldest male. Only in rare cases the household heads are the eldest females. As a result, the mean age of the household heads is generally higher than the younger age cohort of 25–35. These demographic features of the national statistics guided the distribution of household sampling by rural-urban (60% vs. 40%), and male-female headed-households (75.7% vs. 24.3%).

Household income also varies considerably between rural and urban areas in Bangladesh. It is postulated that the varied food consumption patterns between rural and urban populations is associated with different socioeconomic and income status. There are also significant differences in the overall livelihoods, occupational composition and lifestyle of the rural and urban populations. Considering these perspectives, the present study was carried out in both rural and

urban settings. The Sylhet Division in the northeast region of the country and the capital city of Dhaka South were purposefully selected¹ for rural and urban study sites, respectively.

In order to capture the required diversity, rural sample respondents were selected from three randomly selected *Upazilas* (third-tier administrative unit) of the Sylhet Division, namely Borolekha and Kamolgonj from the Maulovibazar District and Derai from the Sunamganj District. Respondents for the urban component of the study were selected from four Wards (new Ward numbers 1, 11, 40 and 41) of the City Corporation of Dhaka South.

A total of 501 households were selected, 200 from urban and 301 from rural areas. The distribution of the sampling units (i.e., the households) was determined using the probability proportional to size (PPS) sampling method, i.e., considering the population size of each *Upazila* and urban-rural ratio. Based on the wealth and socioeconomic status of each household, a stratified sampling strategy was followed in the final stage of the sampling procedure (Thompson, 2012). The sampling frame, consisting of household wealth and socioeconomic status, for each *Upazila* was obtained from the baseline data of previously conducted IDRC project surveys. The specific respondents were then selected randomly from different strata in each *Upazila*.

3.2.2 Household Survey




Household survey data were collected from the 301 rural households in Sylhet Division and 200 urban households in the City of Dhaka South as described above. The household head (both males and females) or lead woman of the household was interviewed face-to-face. The survey instrument encompassed identification of the patterns of consumption of fruits and vegetables, expenditures on fruits and vegetables, and economic and non-economic characteristics of the household. This included collecting information on diet over the last 24 h, food frequencies, smoking habits and other health conditions of the respondent and other household members.

3.2.3. Measuring Daily Food Intake

Using a 24 h recall method, participants were asked for information on fruit and vegetable intake during the previous day. Serving size was determined based on the measuring cup recommended by Bangladesh's national dietary guideline (BIRDEM, 2013). Accordingly, one serving is equal

to: one cup of raw salads or vegetables; a half cup of cooked vegetables or soup; one medium sized piece of raw fruit; and a half cup of chopped fruits or fruit juice. The national standard measurements for serving sizes of fruits and vegetables are shown in Table 3.1.

Table 3. 1: Standardised measurements for fruits and vegetable intake (Showcard for serving size)

Items	Portion Size = 1 Serving	Gm Per Serving	Example
Vegetables			
Cooked vegetables	1/2 Cup	100	 200g cooked vegetable (2 servings) provide 100 kcal
Soup/juice of vegetables	1/2 Cup	80	Lettuce, cucumber
Raw salad/vegetables	1 Cup	80	
Fruits			
Apple/banana/orange	1 medium size	100	 100g banana (1 serving) provides 95 kcal 50g egg (1 serving) provide 70 kcal
Small fruits	2–8 pieces	100	8 Jujubes, 2 plums
Chopped/canned fruit	1/2 cup	80	Watermelon
Fruit juice	1/2 cup	80	Mango, Orange

Source: National dietary guideline for Bangladesh BIRDEM, 2013

3.2.4. Calculation of Belief and Behavioural Practice Index

To analyse the psychosocial aspects of the study, dependent variables were constructed using the additive index of selected pairs of questions from the questionnaire. All questionnaires had a five-point Likert scale response structure (e.g., 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree). With an additive index, a higher value suggests a higher inclination to agree with the statement. Thus, the index score could range from 1 to 10 as two items were added to construct each index. A total of five output variables (i) food belief, (ii) food status, (iii) subjective belief, (iv) environmental practice and (v) economic practice were calculated to examine which

socioeconomic variables help shape these attitudes. The list of the items used to formulate the response variables is shown in Table 3.2.

Table 3. 2 : Index of social beliefs and behavioural practices index.

Additive Index	Items
Food belief	‘Rice is more important than vegetables in everyday meals’
	‘Meat is more important than vegetables in daily meals’
Food status	‘Vegetables are food for the poor’
	‘Fish and meat are food for the rich’
Subjective belief	‘My family members eat enough vegetables’
	‘My family members eat enough fruits’
Environmental practice	‘Formalin on fruits is a more important reason than higher price for low intake of fruits’
	‘Pesticide use on vegetables is a more important driver than price for low intake of vegetables’
Economic Practice	‘If income rises, more meat is purchased than vegetables’
	‘If income rises, more rice is purchased than vegetables’

3.2.5. Statistical Analysis

The econometric analysis focused on determining the sociodemographic factors affecting both social food beliefs and behavioural practices, and low intake of fruits and vegetables. To examine the first, whether and how did social beliefs and behavioural practices affect diet were assessed using an ordinal logistic regression, where the dependent variables had an ordered score ranging from 10 to 1. For the second analytical focus, a binary logistic regression analysis was performed to test the hypothesis concerning the influence of sociodemographic variables on inadequate fruit and vegetable consumption. For this, the dependent variable was constructed as 1 = consumed less than 5 serving of fruits and vegetables per day and 0 = consumed equal to or more than 5 servings per day. Age, level of education, type of occupation, household monthly income, marital status, gender, residence, the habit of eating out and smoking were all examined in relation to participants’ low intake of fruits and vegetables. Multicollinearity was tested prior to the final regression using a correlation matrix among the predictors. Odds ratios (OR) were computed with a confidence interval of 95%. All analysis were performed using the software STATA version 13.

3.3 Results

3.3.1. Socioeconomic Description of the Respondents

Table 3.3 presents summary statistics on the sociodemographic conditions of the two study areas. Of the 501 heads of household (HHs) interviewed, 301 (60%) were from rural areas and 200 (40%) were from urban settings. In rural areas, 81% ($n = 301$) of the participants were male. There were more female respondent HHs in the urban (32%) compared to the rural areas (19%). The mean age of respondents (for both male and female HHs) was 48 years in rural areas. However, in urban areas, the mean age for women was higher (53 years) than in rural areas (48 years).

In rural areas, the majority (60%) of the female HHs were divorced or widowed; in urban areas, it was 33% of the female HHs. Of the male participants, 98% were married. In rural areas, more than 50% of the participants had no formal schooling. Only 2% of the male participants had completed higher secondary or tertiary education, none of the female participants completed higher secondary level. In urban areas, more than 50% of the participants had primary or secondary education. Notably, more than one-third of both male and female participants had either higher secondary or tertiary level of education.

The main occupations of the rural men were day labour (33%), agricultural work (30%) and self-employed (12%). Most rural women identified themselves as housewives (64%). In urban areas, 46% of the men and 25% of the women worked in the business sector, and 28% of the men and 20% of the women worked in the service sector.

The majority of the households (>81%) in rural areas earned less than BDT 15,000 (US \$177.5) per month, and only 2.8% earned more than 30,000 BDT (US \$355) per month. However, 49% of the participants living in urban areas earned more than 30,000 BDT (US \$355) per month.

Given that the mean age was over 48 years, very few participants had children less than 5 years of age. Comparing everyday lifestyle, tobacco use was much higher in rural areas compared to urban areas; 65% of rural males and 26% urban males smoked. Among the female participants, 16% in rural areas compared to 6.3% urban areas smoked. As well, overwhelming majority (88%) of rural female participants chewed tobacco. Noticeably, urban male (40%) and female (21%) participants reported more physical activity than rural participants (only 3%).

Table 3.3 Socio-demographic characteristics of the HH survey participants.

Variables	Rural (<i>n</i> = 301)		Urban (<i>n</i> = 200)	
	Male	Female	Male	Female
<i>n</i>	243 (81%)	58 (19%)	136 (68%)	64 (32%)
Mean Age	48.8	48	48.3	53
Age Group				
25–34	15.6	17.2	17.7	4.7
35–44	23.5	15.5	22.8	17.2
45–55	23.9	32.8	23.5	28.1
55–64	20.2	25.9	20.6	29.7
65+	16.9	8.6	15.4	20.3
Marital Status				
Married	98.4	39.7	97.8	67.2
Divorced/Separated/Widowed	1.7	60.3	2.2	32.8
Religion				
Muslim	62.6	82.8	87.5	85.9
Hindu	37.5	17.2	12.5	14.1
Education				
No formal	52.3	65.5	11.8	9.4
Primary	32.5	31.0	24.3	26.6
Secondary	13.2	3.5	25.7	29.7
Higher Secondary+	2.1	0.0	38.2	34.4
Occupation				
Day labour	33.3	5.2	5.2	10.9
Self employed	11.9	1.7	4.4	3.1
Agriculture	30.5	5.2	-	-
Business	9.1	5.2	46.3	25.0
Service	3.3	-	27.9	20.3
Housewife	-	63.8	-	10.9
No occupation	11.9	19.0	16.2	29.7
HH Income/month (BDT)				
<15000	82.4	79.3	22.3	11.5
15000-30000	13.9	19.0	36.4	26.9
>30000	3.8	1.7	41.3	61.5
Number of Children < 5				
0	53.5	69.0	61.0	68.8
1	26.3	17.2	30.9	14.1
2+	20.2	13.8	8.1	17.2
Smokes tobacco				
No	34.6	84.5	74.3	93.8
yes	65.4	15.5	25.7	6.3
Smokeless Tobacco				
No	38.3	12.1	81.6	71.9
Yes	61.7	87.9	18.4	28.1
Physical Activity				
No	96.7	96.6	78.7	85.9
Yes	3.3	3.5	21.3	14.1

Source: Field surveys by the first author in 2019.

3.3.2. Distribution of Low Daily Fruit and Vegetable Intake

The data regarding the servings of fruits and vegetables the respondents had eaten in the previous day are shown in Table 3.4, and are presented as the percentage of participants in each sociodemographic category who consumed less than and more than the recommended five servings per day. Approximately 92% of participants in rural areas and 75% in urban areas had consumed less than 5 servings of fruits and vegetables over the previous 24 h. This reveals that participants from urban areas were likely to eat more fruits and vegetables than the rural people.

A pattern of consuming more fruits and vegetables was observed with middle-aged (35–55 years old) people, while a decreasing trend was found among people aged over 65 and those younger than 35. Women in the rural areas ate considerably less fruits and vegetables than men, whereas there was no noticeable difference in intake between urban males and females.

Education was found to be a good predictor for intake of more fruits and vegetables. People with secondary, higher secondary and tertiary education were likely to eat more fruits and vegetables in their everyday meals. An increase in earnings was also associated with a higher intake of fruits and vegetables, in both urban and rural areas. Having children less than five years of age in the household also increased the probability of eating more than 5 servings of fruits and vegetables in both areas.

In rural areas, percentage of participants who ate more than 5 servings a day was slightly higher among those who smoked cigarettes (8.3%) compared to no smoking (7.3%), chewed tobacco (8.5%) compared to no tobacco (7.0%) and did no physical exercise (8.2%) compared to regular physical activities (0.0%), unlike their urban counterparts. However, people who ate at the end of family eating sessions and those who bought fast food regularly were less likely to consume more than 5 serving of fruits and vegetables.

Table 3. 4 Descriptive and bivariate χ^2 analysis of sociodemographic variables according to participants' per day intake of fruits and vegetables.

Variables	Rural	Rural (<i>n</i> = 301)		Urban	Urban (<i>n</i> = 200)		<i>p</i> -Value
	N	<5 serving	≥5 serving	N	<5 serving	≥5 serving	
%		92.03	7.97		75.00	25.00	
Age Group							
25–34	48	93.75	6.25	27	85.19	14.81	0.2973

35–44	66	90.91	9.09	42	69.05	30.95	
45–55	77	90.91	9.09	50	74.0	26.0	
55–65+	110	92.73	7.27	81	75.31	24.69	
Sex							0.9953
Male	243	91.0	9.1	136	75.0	25.0	
Female	58	96.6	3.5	64	75.0	25.0	
Marital Status							
Married	262	91.98	8.02	176	73.86	26.14	0.3822
Divorced/Separated	39	92.31	7.69	24	83.33	16.67	
Religion							
Muslim	200	92.00	8.00	174	75.29	24.71	0.2776
Hindu	100	92.08	7.92	26	73.08	26.92	
Education							
No formal	165	94.55	5.45	22	90.91	9.09	0.0000 *
Primary	97	93.81	6.19	50	84.0	16.0	
Secondary	34	76.47	23.53	54	72.22	27.78	
Higher Secondary+	5	80.0	20.0	74	66.22	33.78	
Occupation							
Day labour	84	94.05	5.95	14	85.71	14.29	0.0000 *
Self employed	30	86.67	13.33	8	100.00	0.00	
Agriculture	77	90.91	9.09	0			
Business	25	92.00	8.00	79	65.82	34.18	
Service	8	75.00	25.00	51	78.43	21.57	
Housewife	37	100.00	0.00	7	85.71	14.29	
No occupation	40	90.00	10.00	41	78.05	21.95	
HH Income/month (BDT)							
Low: <15.000	242	94.21	5.79	33	87.88	12.12	0.0000 *
Medium: 15.001–30.000	44	86.36	13.64	58	72.41	27.59	
High: >30.000	10	70.0	30.0	82	68.29	31.71	
Number of Children							
0	170	92.35	7.65	127	77.17	22.83	0.9514
1	74	91.89	8.11	51	72.55	27.45	
2+	57	91.23	8.77	22	68.18	31.82	
Smokes tobacco							
No	133	92.48	7.52	161	72.05	27.95	0.0033 *
Yes	168	91.67	8.33	39	87.18	12.82	
Smokeless Tobacco							
No	100	93.0	7.0	157	71.97	28.03	0.0011 *
Yes	201	91.54	8.46	43	86.05	13.95	
Physical Activity							
No	291	91.75	8.25	162	74.69	25.31	0.4147
Yes	10	100	0	38	76.32	23.68	
Eat at the end							
No	88	85.23	14.77	85	62.35	37.65	0.0049 *
Yes	144	97.22	2.78	32	78.13	21.88	
Eat fast food regularly							
No	159	89.94	10.06	115	67.83	32.17	0.0016 *
Yes	142	94.37	5.63	85	84.71	15.29	

* Significant at $p < 0.05$ level. + These bolded headings are showing the broad categories of variables.

3.3.3. Descriptive Analysis of Respondents' Social Belief and Behavioural Practice in Terms of Fruits and Vegetable Consumption

Bivariate and descriptive analyses of the respondents' beliefs and behavioural practices are shown in Table 3.5. When they were asked if rice was more important than vegetables in everyday meals, the majority of the respondents (73.8%) agreed and only a few (25.6%) disagreed. However, most people (64%) disagreed with the statement that meat was more important than vegetables, which means that, among the three food categories, rice was regarded the most important. A smaller majority of respondents also disagreed with the popular beliefs that vegetables are food for the poor (57.6%), and that fish and meat are food for the rich (51.8%). When respondents were asked whether they think their families eat enough fruits and vegetables, the majority of the participants (>64%) indicated they did not.

A chi-square test revealed that significant differences existed regarding social food beliefs among respondents in different socioeconomic status or income groups. For example, 85% of participants who earned less than 15000 BDT (US \$177) agreed that rice is more important than vegetables, whereas only 44.6% of the higher income group agreed with the statement. Similarly, 58.9% of participants in the low-income group, 21.6% of the middle-income group and only 10.9% from the high-income group agreed that vegetables are food for the poor. People who believed that 'meat and fish are food are mainly for the rich' mostly (65.1%) were from the low-earning groups; such beliefs had lesser effects (10%) up on the high income group. Thus, households with lower income were more likely to agree with popular food-related beliefs that are prejudiced against a higher consumption of fruits and vegetables. Contrary to prejudiced food belief, people with higher income (53%) were more agreeable to the statement that their families eat enough fruits than the lower income group (19%). This is also indicative that higher income status may influence a higher consumption of fruits and vegetables.

Table 3.5 Descriptive and bivariate χ^2 analysis of the responses to the popular social beliefs and behavioural practices according to socioeconomic status.

Attitudes	Statements	Response	%	HH Monthly Income			p-Value	
				Low	Medium	High		
Food belief	‘Rice is more important than vegetables in everyday meals’	Disagree	25.6	13.8	31.4	54.4	0.0000 *	
		Neutral	0.6	0.7	0.0	1.1		
		Agree	73.8	85.5	68.6	44.6		
	‘Meat is more important than vegetables in daily meals’	Disagree	64.0	58.9	73.5	68.5		0.0959
		Neutral	1.3	1.5	1.0	1.1		
		Agree	34.8	39.6	25.5	30.4		
Food status	‘Vegetables are food for the poor’	Disagree	57.6	39.3	78.4	89.1	0.0000 *	
		Neutral	1.1	1.8	0.0	0.0		
		Agree	41.4	58.9	21.6	10.9		
	‘Fish and meat are food for the rich’	Disagree	51.8	32.7	75.5	82.6		0.0000 *
		Neutral	1.7	2.2	2.0	0.0		
		Agree	46.5	65.1	22.5	17.4		
Subjective belief	‘My family members eat enough vegetables’	Agree	32.2	24.0	38.2	50.0	0.0000 *	
		Neutral	6.0	9.1	2.9	0.0		
		Disagree	61.8	66.9	58.8	50.0		
	‘My family members eat enough fruits’	Agree	26.6	19.3	29.4	45.6		0.0000 *
		Neutral	6.4	9.1	3.9	1.1		
		Disagree	67.0	71.6	66.7	53.3		
Environmental practice	‘Formalin on fruits are a more important reason than higher price for why fruits are eaten less’	Disagree	30.9	33.1	22.5	33.7	0.0003 *	
		Neutral	6.8	10.5	2.9	0.0		
		Agree	62.3	56.4	74.5	66.3		
	‘Pesticides on vegetables are a more important driver of eating less vegetables even if the price is low’	Disagree	54.2	47.3	57.8	70.6		0.0012 *
		Neutral	7.9	10.5	5.9	2.2		
		Agree	38.0	42.2	36.3	27.2		
Economic practice	‘If income rises more meat is bought than vegetables’	Disagree	38.6	21.8	51.0	75.0	0.0000 *	
		Neutral	3.6	4.7	2.9	1.1		
		Agree	57.8	73.5	46.1	23.9		
	‘If income rises more rice is bought than vegetables’	Disagree	50.8	34.9	66.7	80.4		0.0000 *
		Neutral	5.3	6.5	5.9	1.1		
		Agree	43.9	58.6	27.5	18.5		

* Significant at $p < 0.05$ level.

Regarding behavioural practices, 62.3% of the respondents agreed and 30.9% disagreed when asked whether formalin is more important than high prices in deterring them from buying more fruits. However, pesticide use on vegetables seemed less alarming for the participants only 38% agreed that pesticide use was a more important factor than high price when buying vegetables. In the case of increased income, respondents indicated that they would be more likely to buy more meat (57.8%) or rice (43.9%) instead of more vegetables.

Significant differences in social practices existed among respondents from different socioeconomic status or income groups (p-values: 0.0 to 0.001). The distribution of social practices with social status showed a similar pattern to what was found for social beliefs, i.e., richer respondents were more likely to disregard prevalent social practices. A total of 73.5% of respondents with lower social status agreed that with an increase in income they would buy more meat whereas only 23.9% from higher status agreed to the statement. Similarly, with an income rise, 58.6% from the lower earning status would buy more rice than vegetables compared to only 18.5% among the higher income group.

In order to analyse the underpinnings of responses to the statement ‘meat is more important than vegetables’, the distribution by educational attainment and occupation was examined. As Figure 1a illustrates, with some level of education, people were less likely to comply with popular, prejudiced beliefs regarding fruit and vegetable intake. Figure 1b further reveals that people who were unemployed or work in the agriculture sector were more likely to subscribe to the idea that ‘meat is more important than vegetables for health’.



Figure 3. 1: Distribution of responses to the statement ‘meat is preferable to vegetables’ by educational attainment (a) and occupational category (b).

On the contrary, patterns in Figure 2a,b indicate that the more highly educated compared to ‘no formal education’ and those in the service sector compared to agriculture were more concerned about formalin on fruits and vegetables over price. Service holders were likely to have higher education background, higher income status, and easier and more access to resources (TV, radio, health worker) to know about food safety than a farmer or a day-labourer.

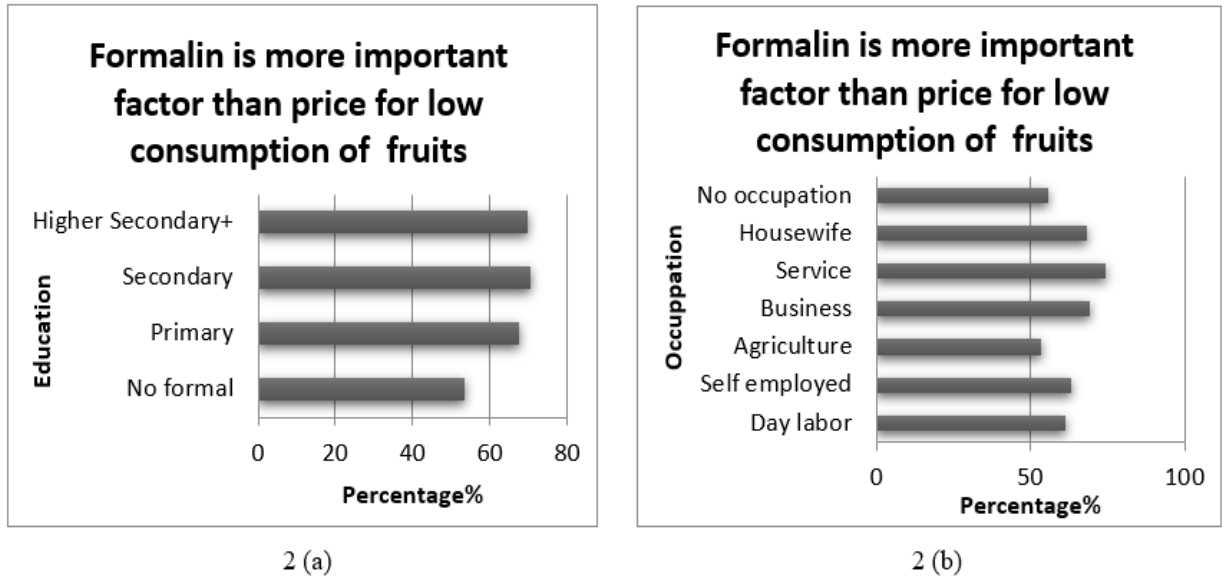


Figure 3. 2: Distribution of responses to the statement ‘Formalin is a more important factor than price for low consumption of fruits’ by level of education (a) and occupational categories (b).

3.3.4. *Econometric Analysis of Social Beliefs and Social Practices in Terms of Sociodemographic and Lifestyle Variables*

Ordinal logistic regressions were performed to assess which socioeconomic variables had more influence on shaping popular beliefs and behavioural practices regarding fruit and vegetable consumption, and the results are presented in Table 3.6. Model 1 revealed that respondents who had higher secondary education compared to those with no education/schooling were less likely to agree with the belief that ‘rice or meat is more important than vegetables’. However, people living in rural areas, businessmen and those who regularly ate processed food were more likely to accept these popular beliefs. Highly educated people seemed to disapprove such beliefs.

In Model 2, respondents who earned medium or higher income in comparison to low income, businessmen and those who had some level of education in comparison with no education background were all less likely to agree that ‘vegetables are food for the poor, and fish and meat are food for the rich’. Respondents living in rural areas who ate processed food were more likely to agree with this idea. In explaining Model 2, higher education and income were found to be most significant.

Model 3 explored the subjective beliefs of respondents regarding the volume (how much) of fruits and vegetables their family eats. Respondents who were female, working in agriculture, with lowest (primary) or highest (bachelor) level of educational backgrounds, and those who ate fast foods regularly (except for those who lived in rural areas), were all less likely to agree that ‘their family eats enough fruits and vegetables’. Income seemed to have no effect on Model 3.

Table 3.6 Ordered logistic regression of popular social beliefs and behavioural practices (odds ratios).

Variables	(1)	(2)	(3)	(4)	(5)
	OR of Food Belief	OR of Food Status	OR of Subjective Belief	OR of Environmental Practice	OR of Economic Practice
Age Group ^{a+}					
35–44 years	0.947 (0.272)	0.719 (0.229)	0.762 (0.225)	1.007 (0.282)	0.503 ** (0.151)
45–54	0.775 (0.221)	0.713 (0.230)	1.193 (0.356)	1.146 (0.330)	0.627 (0.192)
55–64	1.031 (0.310)	0.859 (0.287)	0.956 (0.298)	1.205 (0.353)	0.740 (0.234)
65+	0.979 (0.326)	0.844 (0.322)	0.633 (0.215)	1.240 (0.406)	0.405 *** (0.141)
Education ^b					
Primary education	1.149 (0.249)	0.630 ** (0.142)	0.609 ** (0.135)	1.460 * (0.308)	0.876 (0.191)
Secondary education	0.652 (0.186)	0.514 ** (0.151)	0.720 (0.210)	1.578 * (0.427)	0.661 (0.185)
Higher Secondary+	0.448 ** (0.163)	0.245 *** (0.110)	0.357 *** (0.132)	1.337 (0.468)	0.207 *** (0.0848)
Occupation ^c					
Self employed	0.780 (0.278)	0.779 (0.295)	0.709 (0.266)	1.348 (0.467)	2.346 ** (0.914)
Agriculture	1.084 (0.314)	0.647 (0.199)	0.418 *** (0.128)	0.653 (0.193)	1.192 (0.345)
Business	1.975 ** (0.629)	0.385 *** (0.131)	0.767 (0.247)	1.568 (0.485)	0.707 (0.231)
Service	1.863 (0.719)	0.890 (0.367)	0.863 (0.340)	2.049 * (0.775)	1.968 * (0.784)
Housewife	0.866 (0.359)	0.502 (0.232)	0.863 (0.370)	0.983 (0.406)	0.782 (0.340)
No occupation	1.502 (0.504)	0.859 (0.309)	0.785 (0.272)	0.708 (0.237)	0.999 (0.343)
Income/month (BDT) ^d					
15000-30000	0.876 (0.216)	0.347 *** (0.0881)	0.933 (0.229)	1.486 * (0.352)	0.648 * (0.161)
>30000	0.855 (0.257)	0.251 *** (0.0872)	0.813 (0.256)	1.150 (0.338)	0.564* (0.187)
Married (Marital Status)	1.205 (0.390)	1.033 (0.355)	0.660 (0.218)	1.229 (0.385)	0.437 ** (0.151)
Rural (Residence)	7.602 ***	3.189 ***	1.995 **	5.188 ***	6.812 ***

	(2.348)	(0.957)	(0.584)	(1.496)	(2.116)
Female (Sex)	0.731	0.910	0.600 *	1.051	1.479
	(0.207)	(0.319)	(0.175)	(0.292)	(0.470)
Presence of children < 5	0.956	1.023	0.993	1.008	0.803*
	(0.107)	(0.123)	(0.115)	(0.112)	(0.0933)
Smokes cigarettes	1.077	0.794	1.121	0.948	0.905
	(0.212)	(0.169)	(0.223)	(0.178)	(0.183)
Chews tobacco	1.305	1.407	1.165	0.924	1.552**
	(0.257)	(0.294)	(0.238)	(0.179)	(0.309)
Physical activity	1.430	0.836	1.607	2.104 **	0.724
	(0.476)	(0.328)	(0.526)	(0.662)	(0.273)
Eat fast food	1.405 **	1.617 **	0.726 *	0.794	1.349 *
	(0.242)	(0.314)	(0.130)	(0.135)	(0.244)
Constant cut1	0.394 **	0.254 ***	0.0395 ***	0.440 *	0.276 ***
	(0.172)	(0.116)	(0.0188)	(0.195)	(0.127)
Constant cut2	0.637	0.295 ***	0.0641 ***	0.945	0.366 **
	(0.275)	(0.134)	(0.0297)	(0.414)	(0.167)
Constant cut3	0.907	0.660	0.113 ***	1.601	0.637
	(0.390)	(0.298)	(0.0514)	(0.698)	(0.288)
Constant cut4	1.127	0.727	0.151 ***	2.427 **	0.758
	(0.483)	(0.328)	(0.0680)	(1.057)	(0.342)
Constant cut5	4.088 ***	0.976	0.411 **	6.178 ***	2.138 *
	(1.768)	(0.440)	(0.183)	(2.725)	(0.965)
Constant cut6	13.58 ***	1.337	0.545	8.504 ***	3.539 ***
	(6.033)	(0.603)	(0.242)	(3.780)	(1.606)
Constant cut7	14.57 ***	1.961	0.697	13.39 ***	4.852 ***
	(6.485)	(0.884)	(0.309)	(6.026)	(2.210)
Constant cut8	23.95 ***	2.414 *	0.945	20.21 ***	9.386 ***
	(10.81)	(1.089)	(0.419)	(9.183)	(4.325)
Observations	469	469	469	469	469
Pseudo R-squared	0.0914	0.150	0.0454	0.0266	0.143

^a Reference age: 25–34; ^b reference education: no education; ^c reference occupation: day-labour; ^d reference earning: less than 15,000 BDT; exponentiated coefficients; *t* statistics in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. + These bolded headings are showing the broad categories of variables.

Model 4 showed that respondents who had primary or secondary education, those who exercise regularly, who worked in the service sector with medium income and those living in rural areas were more likely to agree that ‘formalin or pesticide use is a far more important issue to consider than price before buying fruits and vegetables. No significant disagreement found in this model.

In model 5, it was seen that respondents with the highest education, medium to high income, those married with children under five and respondents from the oldest and youngest age

cohorts were less likely to agree with the popular statement that ‘when income rises more rice or meat is bought’. However, people from rural areas who consumed smokeless tobacco, those who bought processed food, who were self-employed and those who worked in the service sector were all more likely to think otherwise.

3.3.5. Econometric Analysis of Low Intake of Fruits and Vegetable in Terms of Sociodemographic and Lifestyle Variables

Table 3.7 presents the results of a logistic regression concerning the association between various sociodemographic and lifestyle factors and low fruit and vegetable intake. Old age, higher education and higher income were found to be associated with a lower probability of a low intake of fruits and vegetables. People in the 55–64 age group were 68% less likely than those in the 25–34 age group to consume low levels of fruits and vegetables. Those with higher education, especially secondary (74%) and bachelor’s degrees (71%), were less likely to eat lower amount of fruits and vegetables in their daily meals. Respondents with medium and high earnings were 43% and 69%, respectively, less likely to be at risk of low fruit and vegetable consumption. No industrial occupation seemed to have had any significant effect on low intake of fruits and vegetables except being housewives.

Respondents who were housewives, those who ate processed food and those eating at the end of family serving sessions were respectively 69%, 48% and 27% more likely to be at risk of eating too few fruits and vegetables, and this pattern was statistically significant. Place of residence (rural vs. urban), sex (male vs. female), having children (under five years vs. no child) and other lifestyle features (e.g., smoking, chewing tobacco, exercise) did not have any significant effects.

Table 3.7. Logistic regression of daily low fruit and vegetable consumption

Variables	<5 Serving of Fruits and Vegetable Intake
Age group ^{a+}	
35–44 years	0.400 (0.228)
45–54	0.422 (0.244)
55–64	0.322 * (0.190)
65+	0.625

Education ^b	(0.424)
Primary	0.721 (0.348)
Secondary	0.265 *** (0.135)
Higher Secondary+	0.290 ** (0.173)
Occupation ^c	
Self employed	1.269 (1.003)
Agriculture	0.970 (0.608)
Business	0.616 (0.352)
Service	1.141 (0.753)
Housewife	10.31 * (12.61)
Unemployed	1.285 (0.830)
Income/month (BDT) ^d	
15000-30000	0.434 * (0.193)
>30000	0.314 ** (0.160)
Married	0.448 (0.293)
Rural	0.832 (0.411)
Female	1.276 (0.554)
Presence of children <5	0.797 (0.163)
Smokes cigarettes	1.452 (0.519)
Chews tobacco	1.065 (0.393)
Physical activity	1.666 (0.836)
Eats fast food	2.517 *** (0.839)
Eat at the end	2.773 *** (1.080)
Constant	23.84 *** (19.34)
Observations	469
Pseudo R-squared	0.216

Exponentiated coefficients; *t* statistics are within parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; ^a reference age: 25–34;

^b reference education: no education; ^c reference occupation: day-labour; ^d reference earning: less than 15000 BDT. + These bolded headings are showing the broad categories of variables.

3.4 Discussion

Results of our investigation reveal that approximately 92% of rural respondents and 75% in urban areas consume less than the recommended five servings of fruits and vegetables every day in Bangladesh. This result is consistent with many other LMICs, such as Mexico and Thailand, where fruits and vegetables are produced mainly to export to other countries (Ramírez-Silva et al., 2009). Participants aged 35–55 were more likely to eat more servings of fruits and vegetables than the youngest (25–34) and oldest (65+) age groups. Although the 18–25 age group is most often found to be the most vulnerable group for low intake of fruits and vegetables, in our study both the young and elderly groups were more vulnerable (Jekielek & Brett, 2005). The prevalence of a low intake of fruits and vegetables generally decreases with age in high-income countries like the USA and France; however, one study also showed that in the USA this holds true among whites and Hispanics but not among the African American population (Jekielek & Brett, 2005). In LMICs, different age-related patterns are likely to appear due to their varied demographic age structure and dynamics. Further research on these aspects is required.

Like most of the existing studies, higher education and a higher income were found to boost the intake of fruits and vegetables in both rural and urban areas (Mayén et al., 2014). The higher price of fruits and vegetables is a usual barrier for low-income people to consume them, even in high income, developed countries. The fact that a higher fruit and vegetable intake is associated with higher education is indicative that those respondents make an informed decision when buying food. However, in some countries, food culture is a more prevalent factor than mere affordability or education level.

In general, people with unhealthy lifestyles are less interested in eating fruits and vegetables. In our study, contrary to this, respondents in rural areas who smoked tobacco or were not engaged in physical activity were found to eat more servings of fruits and vegetables than those who had a healthier lifestyle. Buying cigarettes or chewing tobacco is expensive for most poor, rural people who cannot afford three meals per day. Moreover, rural people usually walk more than urban people because of deficiencies in transportation facilities within the area, and also stores are usually located far from the households. These findings indicate that the rural respondents who

consumed tobacco products were most likely from the higher income groups who could afford both recreational substances and convenient modes of transportation, as well as fruits and vegetables.

Findings about social beliefs and behavioural practices regarding fruit and vegetable consumption in relation to socioeconomic status revealed that people with lower income were more likely to believe in food beliefs and behavioural practices prejudiced against higher levels of fruit and vegetable consumption. The only exception was when participants were asked whether they thought their family ate enough fruits or vegetables, and if formalin was the reason why they did not prefer fruits. As expected, participants with higher incomes and higher levels of education were more likely to agree with these statements. It is apparent that participants were more afraid of formalin than they were of pesticide use in vegetables. Only 38% of participants agreed that ‘pesticides used in vegetables act as an excluding criteria while selecting vegetables for grocery’, whereas 62.3% thought formalin is a bigger impediment. With more income and education, people became more likely to regard formalin as a deterrent for buying fruits, but pesticide use in vegetables followed an opposite trend where with more income and education people were more accepting of vegetables with pesticides.

The fear of formalin in fruits among the Bangladeshi people started during 2005 (Nasreen & Ahmed, 2014). Public discontent over basic food safety and the ensuing political crisis exerted pressure on the government to take quick action on food safety. Consequently, a mobile food court system emerged as a solution, and from May 2005 to October 2006 a total of 2139 mobile court operations were conducted to combat food adulteration (Nasreen & Ahmed, 2014). The courts gathered US \$13,971 in fines, filed over 16,000 cases and imprisoned 782 persons. After these punitive and regulatory measures by the government, people became more afraid of formalin than any other form of food adulteration.

Most respondents (especially low-income people) believed that ‘rice is more important than vegetables in everyday meals’ but fewer people agreed that ‘meat is more important than vegetables’. This implies that rice is the main staple of Bengali peoples’ everyday meals. Meat is not easily affordable for poor people in both cities and rural villages. This finding corroborates the

lesser importance of meat compared to rice. However, when the same participants were asked whether they would buy more meat or rice when income was increased, they agreed with the statement that they would buy a higher amount of meat (57%) than rice (43.9%).

Econometric analysis of the five summative belief (food belief, food status, subjective belief) and behavioural practice (environmental and economic) indices in our study showed that the most significant factors shaping food attitudes were respondents' place of residence, level of education, household income, occupation and access to processed fast food. Age, sex, marital status and lifestyle choices had limited significance and little influence on the indices.

Prevalent social food beliefs promote the notion that 'rice or meat is more important than vegetables' in Bangladesh's food culture. Respondents with higher secondary education were less likely to agree with this statement because they were more aware of the benefits of fruit and vegetable intake. Many of the previous studies similarly found that with higher education fruit and vegetable intake increases (Hall et al., 2009; Kanungsukkasem et al., 2009; Karim et al., 2017). In our study, rural people, businessmen and respondents with access to fast food were more likely to hold this belief regarding the lesser importance of fruits and vegetables. Most rural people in the study area had little to no education and lacked adequate nutritional knowledge, and therefore tended to agree with the statement. Similarly, respondents who favoured fast food or who had no option but to eat from roadside eateries appeared to care more about saving money and time than about nutrition (Lin & Yamao, 2014). Small businessmen did not always have much institutional education, and so the finding regarding them supports the association between education level and social food beliefs.

All independent variables functioned similarly for the food status index as they did for the food belief index, with three exceptions. Higher education, higher household income and being businessmen were all associated with disagreeing with the food status index statements regarding fruits and vegetables being food for the poor and fish and meat for the rich. In the previous food belief index, businessmen, unlike the highly educated respondents, were more likely to believe rice and meat are more important than vegetables, indicating a lack of nutritional knowledge. In respect of the food status question, both businessmen and the more highly educated respondents

were more likely to disagree with the statement. The most likely reason for this disagreement by businessmen was that they no longer belong to the poor socioeconomic class or empathise with the poor. This is similar to Veblen's theory of conspicuous consumption where the wealthy buy luxury goods to signal social status (Bagwell & Bernheim, 1996). In this case we posit that businessmen were mirroring the response of the more nutritionally educated respondents to uphold their higher status.

Both the least educated and the most educated respondents were found less likely to report that they eat enough fruits and vegetables. The probable explanation for the least educated group is related to their low income and the affordability of healthy food every day. Presumably the most educated group know more about nutrition and so were more aware that they were not taking enough servings of fruits and vegetables every day. Being female was found significant only in regard to this statement, which might indicate that females were more often deprived of appropriate amounts of fruits and vegetables, or that, as they were the ones who cook, they knew better than male respondents whether the family eats enough fruits and vegetables.

Environmental practice was the only index where all independent variables were positively related to the index. Attainment of primary and secondary education, being in the service sector and regular physical fitness were all associated with agreeing that concern about formalin and pesticide use were more important factors than price in driving low consumption of fruits and vegetables. Primary and secondary schools in the country always offer educational courses on basic food hygiene (washing hand) to food safety awareness (chemical residue on food) to avoid major food borne diseases. Additionally, several formalin incidents in the country changed the overall consumer demand for safe food however, not so much for nutritious food. This shift in demand and rise in health conscious (physical fitness) influenced people to be more environmentally conscious, which is well reflected in this index. In comparison to day-labour, people who work in the service sector were more likely to be more educated, richer and have had easier access to food safety education that would influence them to put more emphasis on safer food than price. However, contrary to our findings, in some previous studies, sex of the consumer was significant. Female respondents were found to be more environmental and health conscious than males (Tikka et al., 2000).

The regression analysis for predicting low fruit and vegetable intake showed that respondents with higher education, higher income, and from the older age cohorts were at the least risk of low intake of fruits and vegetables. This result is consistent with several other studies (Tikka et al., 2000). Globally, low income is the strongest predictor of insufficient fruit and vegetable intake, and education beyond the secondary level is a key variable in reaching the recommended level of consumption (Frank et al., 2019). In our study, older people had lower odds of inadequate consumption compared to the young adults (25–35 age), which is contrary to the findings of a previous WHO-STEPs study (Karim et al., 2017). One explanation for this difference may lie in the age composition of the WHO-STEPs study, where the majority of the respondents were from the younger (25–34) age group, while in our study the majority of the respondents were from the middle to older age groups.

Moreover, unlike the findings of the WHO STEP study, in our study the sex of the respondents did not affect inadequate consumption, although we found that the occupational category of housewives was more likely at a higher risk of low intake (Karim et al., 2017). A study conducted in five Asian countries found that women were more likely to be at risk of inadequate fruit and vegetable intake in India and Bangladesh, but less likely in some other Southeast Asian countries, namely Vietnam, Indonesia and Thailand (Kanungsukkasem et al., 2009). However, interestingly, in high-income countries women were found to consume more fruits and vegetables than men (Baker & Wardle, 2003; Roos et al., 2001). The main reason for such a pattern is that women in high-income countries are generally more health aware and willing to maintain a healthy diet.

Although the location of residence (i.e., rural or urban) did not appear to be significant in the logistic regression, the descriptive analysis showed a major difference in fruit and vegetable intake. On average, 25% of urban males and females consumed more than five servings each day, whereas it was less than 9% in rural areas. A study in 52 countries found that overall urbanity had no association with low intake of fruits and vegetables, with a difference noted in 11 countries (Hall et al., 2009) On the contrary, urban people in sub-Saharan African consumed a higher amount of fruits and vegetables than their rural counterparts (Mayén et al., 2014; Ruel et al., 2005). With

globalisation, since the 1990s eating habits in Asian countries have shifted from traditional diets (i.e., cereal and low fat-based) to a more Western diet (i.e., more meats, animal fats and refined sugar), primarily due to new international food supply chains and the opening of supermarkets (Popkin & Gordon-Larsen, 2004; Popkin, 2002; Ruel et al., 2005). These forces have enabled greater access to and affordability of a variety of fruits and vegetables for urban dwellers. However, this access and affordability has remained very limited in rural areas (GoI, 1998; Kanungsukkasem et al., 2009). Availability has emerged as a major constraint because most farmers produce chiefly for export and not for the local market (Kosulwat, 2002; Shetty, 2002).

There were several limitations to our study. We used the 24 h recall method to collect data on consumption, and this information was entirely dependent on respondents' own capacity and memory. This self-reported data may result in some over or underestimation of the data. Moreover, in our investigation, we did not capture the aspect of seasonal variations, nor did we achieve a national level of representation. Different social, cultural and geographic factors, as well as variations in lifestyle, habits, nutritional knowledge or cooking styles may also affect the level of consumption, and these were not addressed in the present study (Hall et al., 2009). Further research should be carried out to examine these potential explanatory factors for low fruit and vegetable consumption.

3.5 Conclusions

The objective of this study was to identify the socioeconomic and sociodemographic factors that influence the low intake of fruits and vegetables in Bangladesh, and determine the factors associated with maintaining popular social beliefs and behavioural practices related to prejudices against fruit and vegetable consumption. Both rural and urban residents were studied to gain comparative insights regarding factors that are correlated with fruit and vegetable consumption.

The findings of our study revealed that, on average, 75–92% of the population of Bangladesh do not consume five servings of fruits and vegetables a day, and this is applicable to both urban and rural settings. Gender was not generally found to play any significant role in shaping attitudes or consumption. However, women who are by occupation housewives were more at risk to low consumption of fruits and vegetables. Urban respondents reported eating slightly more servings per day than rural people did.

The location of residence and access to fast food shape social beliefs and behavioural practices significantly. Having a higher income tended to decrease the risk of lower consumption of fruits and vegetables, but did not always help with developing attitudes in favour of healthy food choices. Higher educational attainment was the sole measure associated with achieving both the recommended goal for fruit and vegetable consumption and non-prejudiced attitudes towards their consumption.

Finally, it is recommended that in order to promote adequate fruit and vegetable consumption, policymakers should establish interventions sensitive to placed-based contexts and regional (rural-urban), cultural and psychosocial factors that affect consumer choices and preferences. Governmental policy-formulating agencies need to focus on increasing opportunities for mass education, particularly for females. In this regard, the national budget should allocate more priority to public education and wage-earning job training programs for women. In addition, taking lessons learned from the mass media campaign about formalin concerns, NGOs should also promote Behaviour Change Communications on the benefits of fruit and vegetable consumption. Monitoring food safety and the nutritional quality of local fast food stores, and undertaking appropriate regulatory measures by relevant governmental departments are also necessary to address the low intake of fruits and vegetables in Bangladesh.

In the above chapter, we examined how socio-demographic factors influence fruit and vegetable intake as well as the social beliefs regarding food intake. Findings reveal higher education and income have the most significant impact on forming food beliefs and behavioral practices that are prejudiced against high levels of fruit and vegetable intake. Contrary to the popular belief that assumes women are more likely to eat healthy food in comparison to men, our study showed that sex of the respondents has no significant effect. Although the location of residence (i.e., rural or urban) did not appear to be significant in the logistic regression, the descriptive analysis showed a major difference in the intake of fruits and vegetables. However, to effectively understand the determinants of consumption, we need to further examine the means and ways to increase consumption and stakeholders' perceptions about it. As such, one is required to explore the gap between the perspectives of the experts/policymakers and the general public. In

the following chapter, an attempt is made to map the perceptions and knowledge of the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these food sources.

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Chapter 4:

Facilitators and Barriers to Fruit and Vegetable Consumption in Bangladesh: A Qualitative Study of the Perceptions of the Public and Experts/Policy-makers⁴

Abstract

Objective: To map perceptions and knowledge among the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these food sources.

Design: A qualitative study involving two specific groups: the public and experts/policymakers.

Setting: Interviews were conducted with expert/policymaker key informants, and focus groups were organized with the public in selected rural and urban areas of Bangladesh. Using the findings of these sessions, a modified mental model approach was employed to help formulate perception and knowledge models, and pertinent juxtapositions were identified.

Participants: Thirty public-consumers aged 18 and over, and seven expert/policymaker key informants.

Results: The public relies on first-hand experience, while the experts/policymakers depend more on scientific-technical knowledge. Additionally, the public holds several misconceptions relating

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to the advised daily intake of fruits and vegetables, as well as food safety concerns. Furthermore, the experts/policymakers are inclined to suggest a ‘one size fits all’ solution that is likely not appropriate for the Bangladeshi context.

Conclusion: Considerable perceptual gaps exist between the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladesh. Thus, experts/policymakers must work to improve communication with the public, as this will lead to greater engagement and, consequently, the formulation of more effective policies for increasing fruit and vegetable consumption in Bangladesh.

Keyword: Mental Model, fruits and vegetables, public, expert/policymakers, Bangladesh

4.1 Introduction

For centuries, the main function of food was to satisfy hunger; in the present day, *‘food is a critical contributor to physical wellbeing, a major source of pleasure, worry and stress, and, across the world, the single greatest category of expenditure’*⁽¹⁾. However, changes in diet over the past 40 years have had a negative effect on global health, especially in low- and middle-income countries (LMICs), resulting in an epidemic of obesity and non-communicable diseases (NCDs). Indeed, modern dietary practices are primary factor for the increasing prevalence of non-communicable diseases (NCDs). A survey of the global literature reveals that these dietary changes have been profoundly influenced by the globalization of the market economy⁽²⁾ and the accompanying spread of the ‘Western’ diet, which is predicated on large amounts of livestock, fats, dairy products, oils and fewer staple foods such as fruits and vegetables⁽²⁻³⁾.

As the globalization process since the 1990s brought the local Bangladeshi economy closer to the international economy, primarily through trade liberalization, it also affected a change in the dietary pattern. According to Vepa⁽⁴⁾, there are three expected outcomes of globalization on food intake: i) shifts from cereal to more protective foods, i.e. meat, fish, fruits and vegetables, ii) shifts towards more processed food, and iii) rise of transnational fast food industry. The nutrition transition theory proposes that trending globalization along with an economic growth will shift the diet from minimally processed staple to highly processed foods, meat, and diets high in vegetable oils⁽⁵⁻⁷⁾. This rapid change in diet towards highly processed food is the major contributor to the

rising trend of non-communicable diseases in LMICs⁽⁸⁻⁹⁾. It is suggested that that without considerable policy interventions, this trend of increasing processed food consumption is likely to continue⁽¹⁰⁻¹¹⁾.

Since many diseases are directly related to diet, it follows that dietary changes can play a key role in reducing the severity of a disease. As such, government policy, marketing campaigns, and interventions by private sectors and NGOs have all been deployed to promote the consumption of healthy foods around the world. Unfortunately, our understanding of how to encourage more healthy eating behaviours among humans is still very poor, a fact that has been acknowledged by the World Health Organization (WHO)⁽¹²⁾. The WHO recognizes that our understanding of how to change human behaviour towards healthy eating is still very poor⁽¹³⁾.

One of the main barriers to promoting healthier eating habits through intervention is gaps in communication between experts/policymakers and the public. In the fields of health and the environment (i.e., climate change, cardiovascular disease control), the literature on risk perception and risk communication cites gaps between experts and the public, particularly as they relate to knowledge, attitudes, and perceptions⁽¹⁴⁻¹⁵⁾. There have always been gaps in understanding each other between the scientists, policymakers and the public. Scientists usually tend to regard the policy processes as politically motivated and are not scientifically evidence-based⁽¹⁶⁾, while policymakers perceive scientists as rigid groups in applying methods, and myopic in scope⁽¹⁷⁾. However, policymakers and the scientists both have a consensus in that the public are often driven by emotion without assessing the facts and figures⁽¹⁸⁻²⁰⁾. Notably, the public criticize scientists for taking a narrow (silo) perspective and using unintelligible scientific language and allege that the policymakers are usually too cautious to act on anything driven by mass sentiment⁽¹⁹⁻²¹⁾. One of the most popular methods for addressing such communication problems is the mental model approach, which was first applied for this purpose by Morgan et al.⁽²²⁾ almost two decades ago. The general principle of this model, as formulated by Craik⁽²³⁾, is that the opinions and perceptions of experts are rational, standard, superior, and more correct compared to those the layperson⁽²⁴⁾. In earlier versions of the mental model, scientists/experts were considered to be knowledge producers or validators, whereas the public comprises the ‘political world’, operating in the societal complex. Consequently, scientists and/or experts are the spokespersons of ‘rationality’, while the public and

policy are considered ‘emotional and political’, and thus, inferior ⁽²⁵⁻²⁶⁾. Notably, the literature contains no reports of the use of a mental model to investigate the gaps in communication between the experts and the public regarding low fruit and vegetable intake.

Nonetheless, a modified mental model was applied in a recent study⁽²⁷⁾, which produced findings that challenged the conventional belief that learning flows only from the expert to the layperson. These results were supported by those of several alternative studies, which found that experts may be ‘cognitively handicapped’ with respect to understating a layperson’s limitations in receiving and processing knowledge ⁽²⁸⁾. These findings imply the existence of not only communication and knowledge gaps between the knowledge provider and the receiver, but also limitations in understanding each other’s perspectives and comprehension abilities.

Against this backdrop, we explore the similarities and differences in the knowledge, attitudes, and perceptions of experts/policymakers and the public that hamper the effectiveness of interventions, as well as the formulation of policy and behavioural-change tools. Specifically, this study aims to map the public’s and expert/policymakers’ perceptions of and knowledge about fruit and vegetable consumption in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these food sources.

4.1.1 The ‘Mental Model Approach’ in Food and Nutrition Study

Environmental and health problems are often a direct result of human decisions and actions. As such, these problems can be addressed via social-science constructs like attitudes and behaviours. However, the mental model approach is a unique tool, as it helps to predict the outcome or explore the cause-effect relationships between the concerned variables under study. The mental model approach is most popular in cognitive science and psychology, where it is described as the ‘internal’ representation of the ‘external’ reality ^(23, 29). As one of the major challenges of using the model is finding a way to illustrate the results of the analysis, different visualization techniques are generally applied in different fields of study (e.g., organizational research, risk communication, and education) ^(22, 30-31).

The gap between the experts/policymakers' messaging and the general public's response was identified much earlier in the risk-communication literature⁽²²⁾. To address this problem, Morgan et al.⁽²²⁾ formulated a mental model that compared an 'expert model' and a 'public model' in order to 'map' the gaps between them and develop effective intervention tools. This elicitation technique was also employed in the Carnegie Mellon University-based mental model methodology, which suggested developing an 'influence diagram' to illustrate expert opinions⁽²⁷⁾. The initial influence diagram was developed based on the beliefs, values, and attitudes of experts as recorded in a focus group discussion (FGD) setting. The 'expert model' was considered the standard that was to be compared with the public or other community models during final analysis. In a nutshell, mental model can identify and dissolve misconceived "public ideas" for the expert/policymakers to reconsider⁽³²⁾. The mental model approach has been adopted in many fields, including natural resources management, environmental studies, and risk communication, to explore similarities and differences between the understandings of various stakeholder groups, to integrate the perspectives of different communities, or to identify misconceptions and barriers against behavioural change^(22,33,34). Nonetheless, the application of the mental model approach in the field of food and nutrition has yet to be explored, especially in the context of public health issues.

4.2 Methods

4.2.1 Study area and setting

This study is part of a multicomponent project by the International Development Research Centre (Ottawa, Canada) aimed at investigating fruit and vegetable consumption and NCDs in Bangladesh. A total of three *Upazilas* (sub-districts, which are the third tier in a four-tier hierarchical administrative system) and the capital city of Dhaka South were purposively selected. The selected areas included the Borolekha and Kamolgonj *Upazilas* from the Maulovibazar District and the Derai *Upazila* from the Sunamganj District and four wards (new ward numbers 1, 11, 40, and 41) from the City Corporation of Dhaka South..

4.2.2 Study design and participants

This study utilized a qualitative design consisting of four focus group discussions (FGDs) and seven key informant interviews (KIIs) aimed at understanding the barriers and facilitators to the consumption of fruits and vegetables in Bangladesh. Field data were collected by the first author between October 2018 and December 2018 with the verbal consent of the participants, which was provided at the time of collection. All recruited participants were over 18 years of age, with most being women (4 males and 26 females). This asymmetry in the sample was primarily due to the unavailability of males during the daytime interviews and FGDs. The mean age of the participants was 40.3 years. In terms of religious background, the sample was almost equally divided between Muslims (n=14) and Hindus (n=16). The majority of the participants were housewives (n=18), while the remainder consisted of farmers (n=6), day labourers (n=3), small business owners (n=2), and a driver (n=1).

The key informants (n = 7) interviewed for this study included five government department specialists (science and technology, food safety, nutrition, agriculture, and agricultural extension), one agricultural economist from Bangladesh Agricultural University, and one supply chain specialist from Hortex (a private-sector company). Individuals were selected from different pertinent sectors to provide expert opinions in the fields of horticulture cultivation, training, policy, and implementation.

The FGDs were held in the participants' houses or the courtyards in which they lived. The FGDs and KIIs were led by a facilitator, and a rapporteur was present to take notes and assist the facilitator where necessary. All discussions were held in the local language of *Bangla*, audiotape recorded and transcribed. Interviews were recorded with participants' consent and transcribed tapes were later translated to English by the facilitator with input from the rapporteur.

Community members who were producers and consumers were engaged to represent the public in the formation of the 'public perception and knowledge model', and specialists and policy executives were engaged to form the 'expert/policymaker perception and knowledge model'. The community members (i.e., the public) were invited to reflect on their knowledge, and practices relating to their fruit and vegetable consumption, meal composition in their households, their

household decisions regarding meal choices, major barriers to accessing fruits and vegetables, steps that could be taken to increase fruit and vegetable consumption, and other factors affecting their food intake.

The second cohort of participants, consisting of seven experts/policymakers, shared their perceptions and knowledge relating to appropriate methods of eating fruits and vegetables and related cooking procedures, major barriers preventing adequate consumption of fruits and vegetables, and how to increase the public’s consumption of these food items.

4.2.3 Data Analysis and ‘Perception and Knowledge Model’ construction

All respondents were asked to provide written or verbal consent before starting the formal interviews. All interviews were transcribed from audio recordings. Field team provided assistance to the main author to validate data, while transcribing. The transcripts were classified according to major themes and interview guidebook. Major themes were later divided in to sub-themes and analyzed by the first author. Finally, the emerged patterns of the qualitative data were organized into multiple tables for analysis (Table 4.1).

Table 4. 1: Emerging themes and sub-themes from FGDs and KIIs

	Public Perception and Knowledge Model	Expert/Policymaker Perception and Knowledge Model
Theme 1	<i>Why and how to eat fruits and vegetables</i> Lack of knowledge Cooking preference	Scientific knowledge Cooking procedure
Theme 2	<i>Barriers to eating fruits and vegetables</i> Taste preference Social events and family influence Superstitions in food culture Formalin in fruits and vegetables Price of safe vs. unsafe food	Historical preference Dysfunctional market influence Westernized food culture Misconception of pesticides and formalin use
Theme 3	<i>Ways and means to increase consumption</i> Home-based gardening Collective awareness within family Community-level awareness	Protective cultivation Awareness raising about the benefits of consuming fruits and vegetables Privatization of the market Ending the formalin myth

Data analysis was conducted at the group level and thematic analysis was employed to specify emergent themes from both the FGDs and KIIs. This study did not follow a typical mental model approach; rather, it was inspired by its attributes. While the development of a mental model generally requires a ‘public model’ and an ‘expert model’ with a series of steps of direct or indirect elicitation (i.e., a diagrammatic representation of interviewees’ responses) to formulate the ‘influence diagrams’, we emphasized the participants’ narrative descriptions of the concerned variables or items.

In this study, the causal relationship between the experts and the public was not controlled. Instead, we followed an indirect elicitation that consisted of semi-structured interviews with the experts/policymakers and FGDs with the public separately. The data obtained from the experts/policymakers and the public were formulated into an ‘expert/policymaker perception and knowledge model’ and a ‘public perception and knowledge model’. Each model was thematically organised under three sections: i) why and how to eat fruits and vegetables; ii) barriers to eating fruits and vegetables; and iii) means to increase fruit and vegetable consumption. Finally, the gaps and juxtapositions between the models were identified and analyzed.

4.3 Results

The patterns in the field data revealed three main themes relating to fruit and vegetable consumption: i) why and how to eat fruits and vegetables; ii) barriers against fruit and vegetable consumption; and iii) methods and means for increasing fruit and vegetable consumption. According to these themes, we developed two separate public and expert knowledge models.

4.3.1 Public perception and knowledge model:

The results of the public perception and knowledge model are summarized in Table 2 and the analysis is presented below

Table 4. 2 : Public Perception and Knowledge Model

Theme	Comments made by the public participants
Why and how to eat fruits and vegetables	<i>To fulfill the body's nutritional needs; to regain strength to work the next day; and to accelerate 'brain development of children' so they can perform well in school.</i>
Barriers to eating fruits and vegetables	<i>If the bitter gourd looks too green, it has formalin. If it looks a little less bright, it has no formalin. That's the one I buy. Vegetable consumption increases in the family after having kids. But the kids don't eat much; the mother eats more vegetables after birth because she needs more energy to keep up with the children.</i>
Ways and means to increase consumption	<i>Men's duty is to increase production or to buy the product at the right time; children's duty is to tell what their preferences are; women's duty is to collect the vegetables from their surroundings or to tell their male counterpart what to buy based on the taste of all household members, as well as to cook accordingly. Children follow what their parents are eating, so parents need to eat healthy food.</i>

4.3.1.1 Theme 1: Why and how to eat vegetables and fruits

Lack of Knowledge: All four FGDs (three in rural areas and one in an urban area) began by exploring the importance of eating fruits and vegetables. Most respondents opined those fruits and vegetables were important for meeting the body's nutritional requirements, for helping them to regain strength so they could return to work the next day, and to accelerate the 'brain development of children' so they perform well in school. Regarding the question of how often or how much fruits and vegetables one must eat, most participants in rural Kamolgonj *Upazila* indicated that they did not know how many servings were required each day. However, the answers to this question were different in the other rural area, Borolekha *Upazila*, as workers with a local nutrition project had been very active in the community, teaching the residents about the necessary daily intake of fruits and vegetables. The majority of rural respondents thought they consumed the appropriate volume of fruits and vegetables every day.

The participants were more particular and conscious about their daily intake of fruits and vegetables in the urban areas,. Notably, the urban participants reported eating vegetables three times daily; however, the volume of these servings did not exceed 200g (the field investigators demonstrated a bowl measurement of 200g of food to estimate). While only about 50% of the urban participants said they ate fruit every day, all participants said that vegetables should be included in at least two meals, and that a serving of fruit was sufficient to constitute a single meal.

Cooking preference: Cooking preference largely depended on the presence of children in the family, not the participant's nutritional knowledge or the procedure. Rural participants said they rarely ate meat or fish with vegetables, noting that these items were 'too expensive' to eat with every meal. When they cooked, the rural respondents said that they prepared meals according to the preferences of their children.

In terms of storing cooked or uncooked vegetables, very few households reported owning a refrigerator. Notably, one rural participant said that she would not cook vegetables that had been stored in a refrigerator; the only fresh vegetables that she felt comfortable storing were sweet gourd and ash gourd. In the urban areas, people mostly ate vegetables with fish; however, the respondents also noted that they sometimes did not eat any fish or meat with leafy vegetables. People in the urban areas did not have any reservations when it came to cooking refrigerated vegetables.

4.3.1.2 Theme 2: Barriers to eating fruits and vegetables

Taste preference: Poverty and a shortage of land were mentioned frequently as reasons why rural participants could not obtain enough fruits and vegetables. However, all participants unanimously acknowledged that 'taste preference' was a major influence in their selection of fruits and vegetables.

More diversity of opinion was observed among the urban participants. For instance, some respondents said they did not like sweet gourd because vegetables "are not supposed to be so sweet", while others did not like pointed gourd because they did not like the idea of seeds inside a vegetable. Time was also a significant factor for the urban participants, with most reporting they would not eat leafy vegetables (one participant said bitter gourd) at night because they believed

doing so would cause gastritis or diarrhoea. Furthermore, some participants reported that they avoided eggplant and ash gourds, claiming that they caused allergies and potentially paralysis of the body.

Social events and family influence: Family composition and social events also influenced the participants' food habits. In general, the respondents said that fruit consumption increased when a family member was ill, but that vegetable consumption decreased, as vegetables taste bitter during illness. Additionally, one respondent stated that having children in the family increased the demand for vegetables, and especially fruit, as children have a greater 'demand' for food than the adults. One female participant described the family context in a different manner, remarking that:

'Vegetable consumption increases in the family after children are born and added to the family. Kids don't eat much vegetables; the mother eats more vegetables after birth because she needs more energy at that time to keep up with child rearing'.

During festivals, the people of Bangladesh eat more meat and fish than vegetables, as it is believed that guests are equivalent to God or the Creator and one is obliged to serve them their best (i.e., most expensive) food. Furthermore, the ability to serve one's guest meat and fish is also a marker of social status. However, greater quantities of fruit are consumed during the Hindu festival of worship, or "Puja", as the community members are obliged to offer fruit and sweets to the Saraswathi or Lakshmi Goddess. Additionally, the Hindu worshippers are required to eat an exclusively vegetarian diet until the arrival of the final day of the festival. In contrast, during the holy month of Ramadan (month of fasting), Muslims in Bangladesh consume more fried items and meat than vegetables, along with fruit and fruit juice.

Superstitions regarding food culture: Superstitions and social norms are barriers to the consumption of many varieties of fruit and vegetables. Some fruits (e.g., figs) are not eaten for the simple fact that people in the community have never eaten them, instead leaving them for the rodents and snakes. In the field investigation, it was reported that Hindus in the rural areas of Moulavibazar abstain from eating red radish and jujube during the Bengali month of *Magh* (first month of winter) due to the popular belief that these foods impede a woman's ability to conceive a child. In both the rural and urban areas, most respondents said they never eat jute leaf at night or any fruit on an empty stomach. One participant described this practice, stating that:

‘We don’t eat leafy vegetables at supper. If a snake bites, the person will die, as the poison won’t fully come out, even after applying a tourniquet; leafy vegetables are like that. If we are not careful, we will have to pay the price with a high cost. For this reason, we avoid leafy vegetables at night’.

There are many myths in both the rural and urban areas regarding what not to eat during pregnancy. For example, pregnant women are forbidden to drink coconut water, as superstition holds that ‘those who violate these rules, their kids’ eyes will be white’. Similarly, pregnant women are not allowed to eat bamboo shoots, as there is a superstition that doing so will cause one’s child to ‘look like a monkey’. Moreover, pregnant women are also barred from eating nigella seeds as, ‘these would make the face dark as the seeds’ dark color’.

Formalin in fruit and vegetables: In both rural and urban areas, the participants reported that the women are predominantly responsible for buying and cooking food for the family. While men do a monthly grocery run that includes rice, pulses, or meat, they rarely do the everyday shopping for vegetables for the household. The female participants explained that they select vegetables based on brightness of color (especially green), firmness, and shine, with nutritional aspects only being considered afterwards or not at all. Three participants said they would always buy the greenest bitter gourd and reddest amaranth. However, one urban participant noted that:

‘if the bitter gourd looked too green, it is sure to have formalin. If it looks a little less bright, it has no formalin. That’s the one I buy. We are all very scared of formalin in vegetables. We do not have any tool to check them, so we use our own observations and judgments’.

With respect to fruit, there is a popular belief in Bangladesh society that all bright coloured fruit, especially apples, grapes, oranges, and pomegranates, are full of formalin, and therefore not healthy to consume.

Price of safe vs. unsafe food: The field data revealed that the price of fruits and vegetables was as important as the safety of these items. There is a popular belief that fruits or vegetables containing formalin will look better and be purchased by more affluent people. In contrast, if the item appears a little rotten, the price in the marketplace will drop, as there will be less demand.

Only low-income people will consider buying these items, as they are the only ones this demographic can afford.

All respondents in a rural FGD expressed deep concern about food safety with respect to fruits and vegetables. They unanimously stated that they would consider paying more for local fresh products with no pesticide rather than buying low-priced chemically treated fruits and vegetables. The respondents also suggested some potential adjustments such as purchasing smaller amounts of fruit or vegetables if the price increases.

It is worth noting that the price was the main concern of the majority of urban participants, as most believed that ‘there is no pesticide-free item’ in the market place. As a result, most urban respondents stated that they would eat the cheaper fruits and vegetables than the ones that are labelled as ‘safe and pesticide-free’ (‘because there is no such thing as pesticide free’). Only one urban participant mentioned that she would be willing to pay more for ‘safe and pesticide free’ food.

4.3.1.3 Theme 3: Ways and means to increase consumption

Home based gardening: Participants in rural areas said that having land surrounding the house and receiving subsidized seed from the government would increase the production, and eventually intake of fruits and vegetables. As the study area was a lowland community, one participant suggested raising the seed bed to increase the home-based cultivation of fruits and vegetables. The respondents also suggested that receiving lessons on how to cook vegetables could help them maximize the nutrition they receive from them.

Collective awareness within family: When the rural participants were asked how to increase fruit and vegetable consumption, their replies were generally uniform, with most viewing the issue in terms of the distribution of duties and responsibilities among family members. One respondent summarized this sentiment as follows:

‘Men’s duty is to increase production or buying the product at the right time; children’s duty is to tell what their preferences are; women’s duty is to collect the vegetables from their surroundings or to tell their male counterpart what to buy based on the taste

preference of all household members. Their (women) duty lies also with cooking according to the taste preference of the family members’.

Most participants agreed that, if the children do not want to eat vegetables, they must be taught. The participants opined that such lessons should be developed and taught within the family environment, as well as in the school curricula. One respondent pointed out that children follow what their parents eat, and that parent should therefore lead by example and eat healthy food.

Some respondents noted that cooking practices in Bengali cuisine often entail ‘over-cooking’ vegetables and other items; therefore, these traditional cooking practices need to be changed. The respondents observed that, while using more oil or frying food for a longer time makes it tastier for the children, these practices are also unhealthy. They suggested that a campaign to raise awareness about the adverse health effects of certain traditional cooking practices, particularly among the women, is urgently needed.

Community level awareness: According to the rural participants, the local community can help to increase the consumption of fruit and vegetables in many ways. For instance, the respondents suggested that wealthy farmers could help poor farmers by providing them with production materials, or community leaders could accumulate barren lands and allocate them to poor farmers. The participants also suggested that Muslim community members may decide to eat healthier if *Imams* spoke about the benefits of eating fruit and vegetables in their weekly *Jumma khutba* (sermon).

4.3.2 Expert knowledge and perception Model:

The experts/policymakers’ perceptions on fruit and vegetable intake are summarized in Table 4.3 according to three thematic areas: i) why and how to eat fruits and vegetables; ii) barriers to eating fruits and vegetables; and iii) ways and means to increase consumption.

Table 4. 3 : Expert/policymakers’ Perception and Knowledge Model

Theme	Comments from the experts/policymakers
Why and how to eat fruits and vegetables	<i>Not all expensive food will have more nutrition in it. One piece of amla (Indian gooseberry), which is very cheap, would satisfy the need for vitamin C for a day.</i>
Barriers to eating fruits and vegetables	<i>There is a prominent historical reason why people in Bangladesh eat less fruits and vegetables: it is mainly because of perpetual poverty among the population. Farmers need to understand the demand of the conscious consumers so that those products can be found year-round. More educated and conscious people are in the city, which is why city people are more into eating vegetables year-round. There is a tendency among young working couples to buy more fast food than in previous generations. They are too exhausted to cook after work; thus, readymade fried chicken becomes the solution to all their problems.</i>
Ways and means to increase consumption	<i>Not using chemicals or pesticides is not a practical solution, as commercial production is necessary for meeting the demand at home and abroad for a LMIC like us. These days, kids listen more to their teachers than their parents. If the teachers are appropriately educated about food, the kids will abide by them more.</i>

4.3.2.1 Theme 1: Why and how to eat fruits and vegetables?

Scientific Knowledge: In contrast to the public, the experts/policymakers took a more technical approach to the question of why vegetables and fruits are important. One government official explained that there are three main food groups: i) body building foods, such as proteins (milk, meat, chicken, pulses); ii) energy giving foods, such as carbohydrates and fats (cereals and sugars); and iii) protective foods such as minerals and vitamins (fruits and vegetables). The official went on to note that, among these foods, fruits and vegetables are the most neglected, especially by young people. In addition, it was observed that the price of food does not necessarily correlate to nutritional quality, as ‘not all expensive food would have more nutrition in it’. One respondent illustrated the underlying fallacy of the notion that price and nutrition are closely related by pointing out that ‘one piece of *Amla* (Indian gooseberry), which is very cheap, would satisfy the need for vitamin C for a day’.

Cooking procedure: Several expert/policymaker respondents discussed the limitations of traditional cooking methods and procedures, which often involve deep frying or overcooking vegetables, fish, and meat. One respondent explained that, in general, the public does not know how to cook food properly to obtain the maximum amount of vitamins, minerals, and protein. He added that there are two types of iron: one that comes from animal-based proteins and another that comes from plant-based protein. In both cases, people must cook or prepare these foods using citric acid in order to unlock the iron content. This same principle applies to calcium and vitamin D, as optimal calcium absorption is dependent on the intake of vitamin D, whether through supplements or from exposure to sunlight.

4.3.2.2 Theme 2: Barriers to eating fruits and vegetables

Historical preference: According to the experts/policymakers, food habits, land scarcity, and production capability are the underlying impediments to the sufficient intake of fruits and vegetables in Bangladesh. One agricultural economist described this as follows:

‘There is a prominent historical reason why people in Bangladesh eat less fruits and vegetables: it is mainly because of perpetual poverty among the population’.

He added that, in the past, the production of fruits and vegetables was insufficient to meet year-round demand, as they were only produced only in specific seasons. To fill this deficit, the public usually used a carbohydrate like rice. Additionally, decreases in the amount of arable land over time have reduced the production of fruits and vegetables to subsistence level:

‘Production on one’s own land was the only way to have fruits and vegetables. Otherwise, people had to buy these items from the local market the rest of the year. People got used to eating less of the expensive fruits and insufficient amounts of vegetables in their daily routine. Eventually it became the culture, and it has gotten stronger day by day’.

Dysfunctional market influence: The expert/policymaker respondents underscored volatility in the marketplace as one of the main reasons why fruit and vegetable consumption in Bangladesh remains so low. On this matter, one respondent opined that producers/farmers need to be more

innovative to respond to the year-round demand for fruits and vegetables, especially in the towns and cities:

Farmers need to understand the demand of the conscious consumers, so that those products can be found year-round. More educated and conscious people are in the city, and that is why city people are more into eating vegetables year-round.

Some of the expert/policymaker respondents highlighted various deficiencies in the supply chain that can lead to food adulteration and consequently impact fruit and vegetable consumption. As one respondent explained:

‘Distortions in the supply chain change the market price and quality of vegetables. They come to consumers after traveling down a long chain of market actors. Because of this long chain, the product might become rotten, and this is when damage control becomes very relevant, like medicine, to keep the product fresh for a longer period of time’.

Westernized food culture: Since the 1990s, Bangladesh’s economy and society at large have undergone global economic integration (i.e., globalization), which has resulted in rapid changes in food habits, especially in urban areas. The respondents in the expert/policymaking group observed that the adoption of Westernized food culture has had a detrimental effect on fruit and vegetable consumption in Bangladesh, especially in the cities. One respondent elaborated on this point as follows:

‘There is a tendency among young working couples to buy more fast food than in previous generations. They are too exhausted to cook after work; thus, readymade fried chicken becomes the solution to all their problems’.

Another respondent discussed the situation of the urban family, pointing out that:

‘Children usually follow their parents when developing their food habits. As their parents don’t eat much fruit nowadays, children don’t do what they are told [with respect to eating healthy]; rather, they do what their parents do’.

Misconception of pesticides and formalin use: While the respondents in the public group identified the use of pesticide, herbicides, and formalin by farmers and others in the supply and

value chains to protect and preserve fruit and vegetable crops as a major health concern, the experts/policymakers largely viewed such concerns as being rooted in ‘misconceptions’. One expert mentioned that, in the past, persistent organic pollutants (POP) were the default pesticides used on crops, with standard doses remaining in the produce for three to four months after application. However, progress in the field of agricultural science has significantly reduced the longevity of pesticide residue, with 99% of current pesticides providing fast action and rapid degradation.

Some of the experts/policymakers also highlighted misconceptions about formalin among the public. As one expert explained:

‘Any vegetable that contains fibre does not absorb formalin. A simple water bath could wash out formalin easily. Formalin in protein like meat or fish is more detrimental to health’.

Overall, the expert/policymaker respondents argued that food safety issues are not related to the use of chemicals per se, but are more a matter of their use in appropriate amounts, and the timing and method of their application.

4.3.2.3 Theme 3: Ways and means to increase consumption

Protective cultivation: To increase the consumption of fruits and vegetables, experts/policymakers suggested enhancing supply through agricultural extension activities. Some respondents explained that there are specific cultivation procedures for different agricultural zones, and such zone-specific procedures must be applied to further increase productivity. As one expert pointed out, there are 30 agro-ecological zones in Bangladesh, and growers need to know the specific needs of each zone.

‘A technology exists where one can grow fruits and vegetables at the same time. This multiplies productivity. Floating cultivation and saltwater cultivation are fairly new technologies, but these technologies are not known to all. There is not much connection between agricultural authorities and the growers. These issues need to be addressed for the successful extension of activities’.

Awareness creation about benefits of consumption: The experts/policymakers identified a lack of knowledge and awareness about the nutritional benefits of fruits and vegetables as the core issue for the low consumption of these foods among the population. In addition, they noted that this issue is compounded by the fact that food habits are deeply rooted in tradition and culture. Most expert/policymaker respondents agreed that changing food habits will be much more difficult than changing cultivation methods due to the historical roots of these habits. To this end, they suggested that a nationwide rigorous awareness campaign promoting the motto, '*Food should be medicine, medicine should be food*', may be successful in effecting change in food habits. The experts/policymakers further noted that media coverage of this campaign, which will promote balanced and safe food intake, will be an essential tool in raising awareness about these issues.

Many experts/policymakers also suggested that educational initiatives focused on the children could be an effective approach to altering food habits. One respondent suggested that it would be necessary to provide teachers with training on this subject matter to achieve this goal. He stated that,

'These days, kids listen more to their teachers than their parents. If the teachers are appropriately educated about food, the kids will abide by them more'.

Privatization of the market

In discussing the means and ways of enhancing fruit and vegetable consumption, several experts/policymakers emphasized the need for more privatization and consolidation of the land and agricultural sectors:

'There are only a handful of cold-storage facilities in the country, which is not enough for all the production. If bigger companies were attracted in this field, many more cold-storage facilities would be built, which would eventually reduce post-harvest loss'.

Some respondents viewed the long supply chain as a major reason for price hikes and suggested that this could be controlled via contract farming. They suggested that a demand-induced production model like contract farming would encourage farmers to procure a better price for their products. Furthermore, contract farming is a good approach to mitigate price depression due to overproduction and over supply.

Ending the formalin myth: Most of the experts/policymakers thought that the use of no chemicals or pesticides was not a viable option, as commercial production is necessary to meet food demand on a countrywide scale. They also unanimously agreed that eliminating the ‘formalin myth’ is a major requirement to increasing the consumption of fruits and vegetables in Bangladesh.

According to the respondents, significant quantities of mangoes were crushed by law-enforcement agencies during 2016 because the mobile courts were given the power and authority to determine whether their volumes of formalin residues exceeded the legal limit. The respondents alleged that these mobile courts were using faulty detection equipment and methods that did not account for the fruits’ own hidden formaldehyde (e.g., formaldehyde is naturally occurring in apples at 22.3 mg/kg).

One expert suggested that the formalin issue could be avoided completely if the government restricted the harvesting of mangoes to before May 25th (i.e., before the ripening stage), as this would curb the use of formalin and insecticides.

4.4 Discussion

The objective of the current research was to determine and juxtapose the perceptions and knowledge of the public and experts/policy makers regarding the impediments and drivers of fruit and vegetable consumption in Bangladesh. The themes that emerged during this work were synthesized in three broad categories: i) why and how to eat fruits and vegetables; ii) barriers against eating fruits and vegetables; and iii) means of increasing consumption.

Table 4.4 presents a synthesis of the public and expert/policymaker perception and knowledge models, as well as the gaps that were observed between these models. As is evident, there are notable differences between the understandings and responses of the general public and experts/policymakers. In some cases, the respondents in the public group held on to certain misconceptions due to personal experience; however, this personal experience also often provided new perspectives relating to complex issues and practical solutions. In this section, we explore the

differences and similarities in the responses of the public and expert/policymaker groups in relation to the current literature and the findings of other comparative studies.

Table 4. 4: Comparison of public and policy-experts’ knowledge and opinions with gaps in perception

Themes	Public	Expert/Policymaker	Gaps
Why and how to eat fruits and vegetables	<ul style="list-style-type: none"> -Lack of knowledge. -Cooking preferences. 	<ul style="list-style-type: none"> -Scientific knowledge. -Cooking procedures. 	<ul style="list-style-type: none"> - Experts/policymakers mostly emphasised technical definitions and cooking procedures. - The general public lacks this information.
What are the barriers to the consumption of fruits and vegetables	<ul style="list-style-type: none"> -Taste preference. -Social events and family influence. - Superstitious food culture. - Formalin in fruit and vegetables. - Price of safe vs. unsafe food. 	<ul style="list-style-type: none"> - Historical preference. - Dysfunctional market influence. - Westernized food culture. - Misconception of formalin and pesticides. 	<ul style="list-style-type: none"> - General public perceive the barriers mostly in personal context. - Habitual and cultural influence was more prominent in every barrier. - Experts/policymakers perceived barriers from a broad country context. - Focused mostly on the market dimension.
Ways and means to increase consumption	<ul style="list-style-type: none"> - Home-based gardening. - Collective awareness in the family. - Community-level awareness. 	<ul style="list-style-type: none"> - Protective cultivation. - Creating awareness about the benefits of consumption. - Privatization of the market. - Ending the formalin myth. 	<ul style="list-style-type: none"> - Experts/policymakers’ solutions are mostly production- and market-oriented. - Awareness programme prescribed by the experts/policymakers was more focused on mass scale or the supply chain. - General public-consumers called for an increase in awareness at the personal, family, and community levels.
Themes	Public	Expert-Policymaker	Gaps

Why and how to eat fruits and vegetables	<ul style="list-style-type: none"> -Lack in knowledge -Cooking preference 	<ul style="list-style-type: none"> -Scientific knowledge -Cooking procedure 	<ul style="list-style-type: none"> -Expert-policymaker emphasised mostly on technical definition and cooking procedures. - General public lack of this information
What are the barriers to fruits and vegetable consumption	<ul style="list-style-type: none"> -Taste preference -Social events and family influence - Superstitious food culture - Formalin in fruit and vegetables - Price of safe vs. unsafe food 	<ul style="list-style-type: none"> - Historical preference - Dysfunctional market influence - Westernized food culture - Misconception of formalin and pesticides 	<ul style="list-style-type: none"> - General public perceive the barriers mostly in personal context. - Habitual and cultural influence was more prominent in every barrier. - Expert-policymaker perceives the barriers from the broad country context. - Focused mostly on the market dimension.
What are the ways and means to increase consumption	<ul style="list-style-type: none"> - Home based gardening - Collective awareness in family - Community level awareness 	<ul style="list-style-type: none"> - Protective cultivation - Awareness creation about benefits of consumption - Privatization of market - Ending the formalin myth 	<ul style="list-style-type: none"> - Expert-policymakers' solutions are mostly production and market oriented. - Awareness programme prescribed by the expert-policymakers was more focused on mass scale or in the supply chain. - General public-consumers prescribed the awareness increase in personal, family and community levels.

Why and how to eat fruits and vegetables

Regarding the first theme, the participants in the public group primarily viewed healthy eating as necessary for gaining energy to work and ‘a must’ for the brain development of their children. In contrast, the most important public opinions in the literature hold that healthy eating, especially fruit consumption, is a critical element in preventing disease ⁽³⁵⁾. Unlike the experts/policymakers, who rely on scientific and specialized knowledge, the public’s mental and knowledge map is more reliant on experiential knowledge. However, the respondents in the public group also had some

misconceptions about the recommended daily intake of fruits and vegetables. It appeared that, as a result of local project activities, participants from one rural zone were more aware of how much fruits and vegetables they were supposed to be eating each day compared to the respondents from the other rural zone.

In contrast, the experts/policymakers identified fruits and vegetables as being the most important protective components of the food pyramid, as well as the most neglected food group among the general public. It is apparent that the experts/policymakers gained their knowledge from specialized education and training, whereas the public gained their knowledge from their peers and surrounding resources, for example, health and NGO workers and neighbours.

Another key difference between the public and experts/policymakers was observed in their responses regarding cooking procedures and their effect on nutrition. Whereas the experts/policymakers focused more on cooking procedures that would preserve the nutritional value of the food, the public placed more emphasis on taste preferences and maintaining traditions. As in the present study, a few other studies have found that healthy eating is strongly influenced by the family environment, especially if a female or a child is present in the family⁽³⁵⁾.

Barriers to eating fruits and vegetables

The second theme aimed to identify barriers to eating fruits and vegetables. When asked to describe the largest impediments to eating enough fruits or vegetables, the rural respondents in the public group identified poverty and not having enough land to practice horticulture as the top two barriers. Conversely, the urban respondents gave two separate responses for fruits and vegetables: while taste was cited as the most important factor related to vegetable consumption, safety was the dominant issue when it came to fruit. Taste preference has also been frequently mentioned in other studies exploring barriers to eating fruits and vegetables⁽³⁶⁾.

The experts/policymakers also agreed that, historically, poverty and land scarcity have rendered a key part in shaping current taste preferences and the low levels of fruit and vegetable intake. The experts/policymakers also agreed that food safety concerns among consumers in Bangladesh are a fairly new phenomenon that emerged after the 2005 formalin incidents.

Similarly, a study of expert views on the effectiveness of food schemes (i.e., Supplemental Nutrition Assistance Program (SNAP)) in the USA found poverty and the high price of nutrient-rich foods to be the major reasons why such interventions were not fully effective⁽³⁷⁾.

According to respondents in the public group, the influence of work culture, family norms, and social events were also major impediments to fruit and vegetable consumption. In Bangladeshi culture, as in many traditional societies, ‘signaling’ the social status and honour of one’s family can only be performed by serving expensive fish and meat dishes during social and family occasions. In Bangladesh, there is a belief regarding the status of food: low status food is often called ‘poor man’s crops’, and expensive foods are called ‘rich man’s crops’⁽³⁸⁻³⁹⁾. In contrast to public sentiment, the policymakers placed more focus on distorted market ‘signaling’ and problems stemming from a long supply chain. According to the policymakers, the solely profit-seeking mentality among many of growers and the market’s vulnerability to volatility has increased uncertainty relating to supply and the price of the fruits and vegetables. As a result of these changes in price, fruits and vegetables have become even more inaccessible to the general public in Bangladesh.

While public opinion relating to barriers was informed by many of the superstitious food norms that permeate Bangladeshi society, the experts/policymakers’ concerns focused more on the adoption of Westernized food culture in the cities in recent decades. Even though the experts cited the current rise of Westernized junk food as a major reason for the reduced intake of fruits and vegetables in Bangladesh, the concerns expressed by the public responders did not touch upon junk food culture directly.

The general public strongly believed that most fruits and vegetables in Bangladesh contain unhealthy amounts of formalin, with this suspicion being more prominent for fruits than vegetables. In contrast, the experts/policymakers suggested that danger due to formalin content in fruits and vegetables is a myth that is rooted in technical errors associated with the first major broadcasted case in 2005. In the aftermath of this incident, public discontent over food safety placed immense pressure on the government to initiate a mobile court system, which collected \$13,971 in fines from 16,000 cases in its first year of operation⁽⁴⁰⁾. However, both the

experts/policymakers and the general public agreed that concerns relating to formalin are a major impediment to promoting the consumption of fruits and vegetables.

Several studies have found concerns relating to pesticide residue as a major impediment to the consumption of vegetables ⁽³⁵⁾. However, the urban respondents in the public group believed there was no such thing as a product free of chemical residue, and hence, did not give much weight to pesticide use in their decision making. Policymakers agreed that the overuse of pesticide could result in unsafe food, but they also noted that this outcome was more likely to occur due to unskilled and untrained growers. Even though the public and the experts/policymakers agreed that chemical pesticides are an impediment to healthy eating, the public focused more on the health effects of pesticides, while the experts/policymakers focused on the cause of the problem (i.e., grower's lack of necessary skill).

Means to increase consumption

Both the public and experts/policymakers suggested a variety of ways to increase fruit and vegetable consumption. The first and most prominent suggestion from the public respondents was to enable more home gardening using government-subsidized seeds. The female participants also suggested that they would be willing to change their cooking practices if they were given lesson on proper cooking procedures and taught about nutrition.

In many cultures, the decision-making roles for men and women are defined similarly to hunter-gatherer and pre-industrial farming cultures, where men hunted for meat and women gathered vegetables and fruits. As a patriarchal society, there is a perception in Bangladesh that men are the main decision-makers when it comes to purchasing groceries. However, in the context of present-day Bangladesh society, our findings, along those of a few other studies, indicate that women are the sole decision-makers with regards to purchasing groceries ⁽⁴¹⁾.

Similar to Say's law, which states 'supply creates its own demand'⁽⁴²⁾, the experts/policymakers suggestions for increasing fruit and vegetable consumption mostly focused on the supply side (production) of the problem. However, the general public emphasized demand-driven solutions. For their part, the experts/policymakers suggested that teaching farmers about

protective cultivation and the privatization of the market, encouraging more contract farming, and enhancing awareness through mass media could all potentially improve the supply of fruits and vegetables, and therefore consumption.

An emphasis on the supply–side solution by the policymakers is common in the developing agrarian society, mostly due to post-harvest loss and insufficient domestic production. In Bangladesh, 13.5% of post-harvest loss occurs for grains and up to 40% loss for fruits and vegetables^(43, 44). Except for shrimp, no other food product is exported in high volume, whereas almost all major food items are exported. Each year more than 100 metric tonnes of fruits and 50 metric tonnes of vegetables are imported⁽⁴⁵⁾. Attention to increase value-adding food products in the country is therefore needed.

Furthermore, a study in Iran revealed that, for nutrition education, targeted interventions in schools or other educational institutes are highly effective, as children are a link between the family unit and educational messaging⁽⁴⁶⁾. Indeed, nutritional education is part of the elementary and secondary curriculum in a number of countries, including South Africa, China, and England⁽⁴⁷⁾. Notably, the public’s suggestions targeted educational interventions (i.e., for women of the households or children) have widely examined in the literature.

4.5 Conclusion

This study sought to understand the perceptions of the public and experts/policymakers in Bangladesh regarding barriers to consuming the recommended daily intake of fruits and vegetables, as well as ways of increasing consumption. In doing so, we aimed to show experts/policymakers the gaps in current interventions and policies, and to identify effective policy directions to enhance the consumption of fruits and vegetables in Bangladesh and, thus, curb the rise non-communicable diseases.

Our study was inspired by the mental model approach, which conventionally takes expert opinions as the benchmark of knowledge, perception, and solution. However, the modified mental model approach shows that learning is not a one-way process that flows from the experts to general public⁽⁹⁾. Rather, the adapted mental model approach confers equal status to public perception and

knowledge, thus making it a parallel framework. The present study has attempted to utilize this feature of the modified mental model.

By rejecting the traditional mental model approach, we tried to capture the perceptions and knowledge of the general public and experts/policymakers' to broaden the policy-intervention horizon of healthy and safe food consumption. This nuanced and complex approach revealed that experts tend to define any health hazard of importance based on technical knowledge, while the public relies more heavily on personal experiences.

While the experts/policymakers discussed barriers to and means of increasing fruit and vegetable consumption, they kept their horizon within the broader context of production (i.e., the supply chain and market), whereas the public's perspectives mainly focused on social norms, family, social events, and social status. Instead of a mass awareness program, the respondents in the public group emphasized providing more education to parents, especially the women of the household who control the kitchen. From the findings of this study, it is apparent that target group interventions (school, women, etc.) will work better alongside the necessary mass awareness programs. Ultimately, this research shows that it is necessary to engage both the public and experts in developing interactive interventions and policies aimed at reducing the prevalence of non-communicable diseases in Bangladesh.

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Chapter 5:

Discussion and conclusion

5.1 Introduction

Bangladesh has achieved considerable improvement in ensuring food security for its large population (FAO/WHO, 2014), but it is now facing the challenge of making sure that its people are getting the minimum required intake of fruits and vegetables in their diets. After achieving independence in 1971, Bangladesh's primary focus was reducing undernutrition among its citizens; in contrast, over-nutrition has become a key concern following the cultural and economic globalization that began in the 1990s. Indeed, economic growth and rapid urbanization have contributed to more unbalanced dietary habits, which have produced new dimensions of under- and over-nutrition in Bangladesh. Additionally, trade liberalization has created greater product diversity in the marketplace, largely due to the importation of processed foods and Westernized fast-food culture. Processed foods and fast foods usually do not include fruits or vegetables; rather, these foods are more energy-dense, carbohydrate- and fat-rich products. This is problematic, as the urban working population and young people are eating more processed food and fast food and less fruits and vegetables. This dietary shift has led to the proliferation of many noncommunicable diseases (NCDs), including cardiac diseases, hypertension, obesity, diabetes, and cancer. Many developing nations have referred to this trend as an "epidemiological transition," which denotes a shift wherein chronic diseases associated with urban lifestyles now pose a graver threat than infectious diseases.

Although numerous studies have shown how increasing fruit and vegetable intake can halt this "epidemiological transition" (i.e., reduce the risk of NCDs), only a handful have examined the factors influencing fruit and vegetable consumption in Bangladesh (WHO, 2011; Popkin, 2006). Some of these studies have analyzed the economic or the demographic factors, but few, if any, have explored the non-economic psychosocial factors (Karim et al., 2017; Awal et al., 2008). In addition, none of the studies focusing on Bangladesh have fully examined how cognitive factors, such as attitudes, taste preferences, practices, or environmental concerns, or food quality influence consumption preferences and demand. Thus, the ultimate purpose of this research was to fill in the gaps and explore any inconclusive results. To this end, this study aimed to achieve three key objectives: i) to determine how economic factors (i.e., income and price) affect fruit and vegetable

consumption; ii) to assess how fruit and vegetable consumption is influenced by non-economic factors such as demographic characteristics (e.g., wealth, children, education, gender, region), popular social beliefs, and behavioural practices; and iii) to map the perceptions and knowledge of the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these foods.

5.2 Key Findings of the Study

Each of the three aforementioned objectives was achieved, and the related findings and analyses have been presented in the preceding three chapters. The key findings presented in these chapters are synthesized below.

Objective 1: Understanding how economic factors (income and price) influence the consumption of fruits and vegetables.

In Chapter 2, the results relating to price elasticity and income elasticity revealed that consumers tend to increase their intake of fish, meat, and rice, rather than fruits and vegetables, when their income increases. Fruits and vegetables are still not a desirable substitute for meat and fish when their price falls (incomes rise). Notably, the results indicated that educational attainment was the sole driving factor of increased fruit and vegetable consumption. Unlike other studies, the middle-aged, the elderly, and female respondents were not significantly more concerned about eating fruits and vegetables; however, the male household heads were slightly more inclined to consume healthy food (Dean et al., 2009; Martikainen et al., 2003). Although the females who participated in this study were mostly widowed or separated, they were nevertheless considered to be representative of the female population. The overall findings in Chapter 2 revealed that, while expenditures on fruit and vegetables did not significantly differ between male- or female-headed households, they did differ significantly between rural and urban areas. In addition, differences in price responsiveness to various products were observed in the urban and rural settings.

Objective 2: Identifying and examining non-economic determinants of fruit and vegetable consumption, including demographic characteristics (age, wealth, marital status, children, education, gender, region), popular social beliefs and prejudices, and behavioural practices.

The main goal of Chapter 3 was to identify the socioeconomic and demographic factors, as well as the social beliefs, prejudices, and behavioural factors responsible for the low consumption of fruits and vegetables in Bangladesh. The findings revealed that, on average, 75-92% of rural and urban participants did not consume the recommended five servings of fruits and vegetables per day. Unlike many studies, the findings of this work showed that gender did not play a significant role in shaping behavioural attitudes or consumption patterns. However, women who reported being only housewives were more likely to consume low levels of fruits and vegetables. Attaining higher education was found to be the only measure strongly related to consuming the required amounts of fruits and vegetables and holding non-prejudiced social beliefs and attitudes towards healthy eating. In addition, the participant's location of residence (i.e., urban or rural) and the availability of fast food had a considerable influence on shaping their dietary beliefs and practices.

Objective 3: Map perceptions and knowledge of the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladesh, and to identify the facilitators and barriers to increasing the consumption of these foods.

In the fourth chapter, we sought to assess the perceptions of the public and experts/policymakers regarding the impediments and facilitators of fruit and vegetable consumption in Bangladesh. In general, the opinions of the experts/policymakers are considered to be more well-informed than those of the general population (i.e., novices/layperson). However, many studies have shown that experts are not always able to correctly estimate how novices will go about completing a task. Similarly, a experts/policymakers may not always be able to predict how members of the general public will respond to an unfavourable situation. The experts/policymakers and general public both agreed that poverty and land scarcity were the primary impediments to fruit and vegetable consumption in Bangladesh, but there was considerable divergence in their answers when asked to define “healthy eating” and describe how to cook properly. Whereas the experts provided a science-based definition of healthy eating and described a more systematic cooking procedure, the general public generally cited experiential knowledge and cooking preferences, respectively, in response to these questions. In addition, the two groups had significantly different ideas of how to increase the consumption of fruits and vegetables. For instance, the experts/policymakers

suggested an approach based on broadening awareness through mass media education, while the general public expressed a preference for training aimed at specific groups such as women, as they are usually in charge of the kitchen.

5.3 Major Contributions of the Research

The findings of this research make major contributions to a number of different areas. These contributions are discussed below.

- These findings contribute to the literature relating to the disaggregated demand elasticity of fruits and vegetables in Bangladesh. Whereas most prior studies use national-level aggregated secondary data, this study uses primary data from a concentrated study area (Dhaka South and Sylhet), which provides a clearer picture of the selected area.
- Most prior studies focusing on the demand elasticity of fruits and vegetables in Bangladesh have used models based on linear Almost Ideal Demands Systems (AIDS), which are unable to capture the non-linearity in consumption patterns. In contrast, the present study was able to capture non-linearity in consumption patterns by employing Quadratic Almost Ideal Demand Systems (QUAIDS). Thus, the present study makes a unique and novel contribution to this area of research.
- This research illustrated the detailed income elasticity of disaggregated (itemized) fruits and vegetables in rural and urban settings, which has hitherto been missing from literature relating to Bangladesh. The findings of this work also showed that higher income resulted in increased consumer demands for expensive fruits or vegetable, but not necessarily fruits and vegetables with higher nutritional content. Hence, inexpensive vegetables like eddoe became less desirable (expenditure elasticity 0.84) as income increased, while expensive vegetables like cauliflower (0.96), bottle gourd (1.02), and tomatoes (1.06) became more desirable.
- The present study's findings also broaden our knowledge relating to the gender dimensions of consumer preferences. Unlike in HICs, the presence of female head-of-household did not significantly affect fruit and vegetable consumption in Bangladesh. However, female respondents who identified as homemakers were found to be at greater risk of low fruit and vegetable intake.

- This study identified patterns of fruit and vegetable consumption in Bangladesh, and it enhanced our understanding of the differences in consumer demand and price responsiveness in urban and rural areas. This represents a major contribution to the literature.
- Unlike other studies focusing on Bangladesh, this work captured popular social beliefs and behavioural practices using Likert scales, which allowed us to identify the socio-demographic factors contributing to the respondents' food-related beliefs and practices. Econometric analysis of the five summative belief (food beliefs, food status, subjective beliefs) and behavioural practice (environmental and economic) indices revealed that the most significant factors shaping food attitudes were the respondents' place of residence, level of education, household income, occupation, and level of access to processed or fast food. Age, sex, marital status, and lifestyle choices had limited significance and little influence on the beliefs and practices.
- Finally, this research identified that there are considerable gaps between the knowledge and perceptions of the general public and experts/policymakers regarding the drivers and barriers to eating fruits and vegetables.

5.4 Policy Implications

The major policy implications of this study's findings are as follows:

- The results of this study strongly suggest that the effectiveness of food and health policy can be enhanced by focusing on region-based interventions, as such initiatives are more responsive to the social and economic realities of the communities they are intended to serve.
- Regarding policy formulation, governmental agencies in Bangladesh should focus on increasing opportunities for education, beginning with the addition of nutrition lessons to primary and secondary curricula.
- The national budget should make education and wage-earning job training programs a higher priority, as doing so can reduce the income constraints affecting rural areas. Also, income generation opportunities for women need to be increased so that their decision-making capacity is increased.

- Economic theory holds that consumers and households purchase foods or products to maximize utility according to their preferences, which is also subject to budgetary or income constraints. However, income is not the only constraint; there is also a time constraint (Becker, 1965). According to household production theory, to produce a commodity (here, preparing food) one must market goods and time, which is determined by technology. There are two types of household technology: human capital (knowledge of food preparation) and physical capital (kitchen equipment). For both high- and low-income consumers, there is always substitutability between time and money expenditures in preparing food. For example, cooking traditional food is usually more (vegetable dish) time consuming than any fast food, which is why instant noodles were the first fast food product to be widely recognized in the Asian region (Buisson & Garrett, 1992). Thus, higher income opportunities will provide people with access to physical technology (kitchen equipment such as microwave oven), which can relax the time constraint and allow them to consume fresh or traditional food. Higher income may also enable households to hire a cook, which would be a trade-off between money and labour rather than money and capital.
- NGOs should also promote behaviour change communications (BCC) promoting the importance of fruits and vegetables, particularly for female audiences. However, while this approach can be effective, it is also slow and takes longer yield results.
- Attention must be devoted to formulating food and price policy accounting for rural and urban areas, especially for the low-income population.
- Monitoring the safety and nutritional quality of food served at local restaurants and the implementation of appropriate regulatory measures by relevant governmental departments will also be necessary to increasing the intake of fruits and vegetables.
- Despite several policy measures aimed at increasing the consumption of fruits and vegetables, people in Bangladesh are still not consuming the required amounts of these foods. The failure of these policies is likely associated with the prevailing gap between the advice of the experts/policymakers and the public's perception regarding dietary choices. This gap can only be minimized by cultivating more effective dialogue between consumers, and experts/policymakers.

- The westernization of the food system has created a critical situation for smallholder farmers. The rapid liberalization of trade and the importation of exotic foods have served to exclude these smallholder farmers from this new food system. To integrate them, the government should consider rural investment and agricultural subsidies to allow these farmers to compete in the local and global markets. Furthermore, access to improved agricultural and nutritional knowledge, communication, transportation, cold storage, refrigerated trucks, and technology would enable smallholder farmers to increase their production and compete in the international market. If the local market can provide a standard product, pressure on the import market will decrease and GDP will eventually rise.
- Finally, the government should invest in research to improve seed quality and shorten the duration of cultivars, in addition to developing research facilities to work on increasing agricultural productivity.

5.5 Reflections on This Thesis Research

This study has revealed numerous patterns in the consumption of fruits and vegetables among rural and urban populations, along with their underlying causes and factors—which are illustrated via some interesting facts and figures. While most of the figures support the literature reviewed in the respective chapters, the descriptive statistics sometimes showed greater magnitude, even though they were not found to be statistically significant in the econometric/inferential analysis. Gender was found to be one of these statistics. Specifically, the descriptive statistics revealed that male household heads eat slightly more fruits and vegetables than female household heads. Whereas other studies have found that the middle-aged, the elderly, and women are more concerned about eating fruits and vegetables, the findings of the present work indicated that men are more likely to consume healthy foods. This may have little to do with “health concerns,” and simply be a reflection of the Indian subcontinent’s patriarchal culture in which men eat first and/or more food compared to women. An analysis of the eating patterns of the men and women, or husband and wife, in the same household would likely provide a clearer perspective on this finding.

In each of the chapters, the findings indicated that more education, and thus, enhanced awareness, would increase fruit and vegetable consumption among women. However, this approach may be counter-productive or ineffectual, as other findings in the present study have shown that households headed by women with a post-secondary education tend to spend less on fruits and vegetables compared to male-headed households. The most likely reason for this finding is that these female household heads did not have paid employment. In their study on rural labour markets, Mahmud and Bidisha (2016) observed that women with higher education were less likely to find work due to their expectations not being met by the existing job market. Thus, higher education in the absence of adequate job opportunities will not result in increased fruit and vegetable consumption. While we recommend continuing to increase educational levels among Bangladeshi women, it may also be necessary to create employment opportunities and to bring about a change in gender relationships at the household level.

In this study, we observed that female- and male-headed households spent similar amounts on fruits and vegetables, which runs counter to the popular belief that female-headed households spend more on healthy foods. However, the majority of the female household heads in this study were either widowed or separated, which made it difficult for them to make ends meet. Notably, the insufficient number of widowed/divorced male household heads in our study made it impossible to determine whether they would act differently than their vulnerable female counterparts. This is a topic that should be explored by future research.

In our interviews with the experts/policymakers, they emphasized that the public's fear of formalin is a myth. However, there might be some bias in this statement, as most of the expert interviewees were government civil servants. Interviewing more private-sector experts may provide a more objective perspective, as these individuals would be outside the influence of government pressure.

The target interventions presented in this work are aimed at behavioural change among people with low income and less education, especially women and children. None of the chapters in this work consider how to change the mind-sets of people with higher incomes or lower levels of awareness, or males in general.

5.6 Future Research Directions

- Different social, cultural, and religious factors, as well as variations in lifestyle, habits, nutritional knowledge, and cooking styles may influence fruit and vegetable consumption. However, these factors were not addressed in the present study. Further research should be conducted to examine the impact of these potential explanatory factors on fruit and vegetable consumption.
- The study presented in Chapter 3 did not test the social beliefs and behavioural practice indices (explanatory variables) against the low intake of fruits and vegetables (dependent variable). Future research should explore which attitudes or practices have a major influence on fruit and vegetable consumption.
- As an LMIC, it may not yet be effective for Bangladesh to devote significant effort to indigenous and organic cultivation, as most producers and consumers are not familiar with the correct definition of organic. However, the demand for organic food is slowly growing in Bangladesh; as such, research should be conducted to understand how effective organic or Indigenous cultivation practices can be in reducing NCDs.

5.7 Major Limitations of the Study

This study had three major limitations:

- In my research, I used the 24 h recall method to collect data on consumption. Since this self-reported information was entirely dependent on the respondent's capacity and memory, some data may be over or underestimated.
- In the present study, it was not possible to capture the aspects of seasonal variations. This is a limitation with respect to the applicability of this work's findings to year-round food and health policies.
- Finally, it was not possible to use a national-scale sample. Therefore, the inferences made in this work should be taken with caution.

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Appendix

Appendix 1: Ethics approval from University of Manitoba



Research Ethics
and Compliance

Human Ethics
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PROTOCOL APPROVAL

TO: Sadia Mustafa (Advisor: C. Emdad Haque)
Principal Investigator

FROM: Julia Witt, Chair
Joint-Faculty Research Ethics Board (JFREB)

Re: Protocol J2018:044 (HS21997)
Patterns and Determinants of Consumers' Preferences and Demand for
Fruits and Vegetables in Bangladesh

Effective: August 31, 2018

Expiry: August 31, 2019

Joint-Faculty Research Ethics Board (JFREB) has reviewed and approved the above research. JFREB is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*.

This approval is subject to the following conditions:

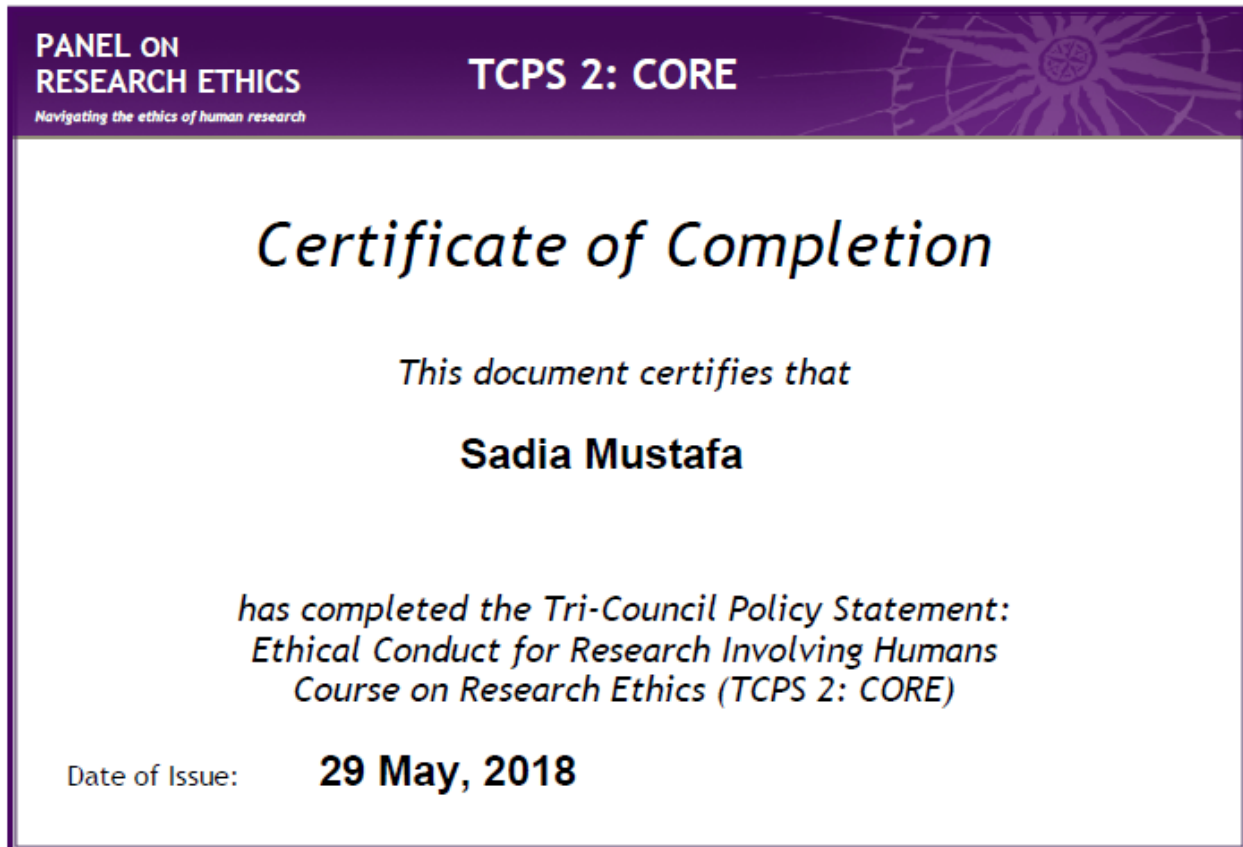
1. Approval is granted only for the research and purposes described in the application.
2. Any modification to the research must be submitted to JFREB for approval before implementation.
3. Any deviations to the research or adverse events must be submitted to JFREB as soon as possible.
4. This approval is valid for one year only and a Renewal Request must be submitted and approved by the above expiry date.
5. A Study Closure form must be submitted to JFREB when the research is complete or terminated.
6. The University of Manitoba may request to review research documentation from this project to demonstrate compliance with this approved protocol and the University of Manitoba *Ethics of Research Involving Humans*.

Funded Protocols:

- Please mail/e-mail a copy of this Approval, identifying the related UM Project Number, to the Research Grants Officer in ORS.

Research Ethics and Compliance is a part of the Office of the Vice-President (Research and International)
umanitoba.ca/research

Appendix 2: Certificate for completion of TCPS2: Core



Appendix 3: Interview Checklist for Focus Group Discussion

A. FGD Checklist for the public consumer:

Participant:

Location:

Date:

1. How does the way we eat fit into your idea of being healthy?
2. Why do you think we are looking at how much fruits and vegetables you eat?
3. Is it necessary to you to eat fruits and vegetables [every day, week, frequently]? Why?
4. Name some fruits that you don't eat.
5. What are some of the things that keep you from eating fruits?
6. Name some vegetables that you don't eat.
7. What are some of the things that keep you from eating vegetables?
8. What are the things that you consider when buying fruits and vegetables? (decision, cooking style, texture of product)
9. What are some of the things that could help you make changes in your eating habits?
10. Do you think you could do anything to increase the amounts of fruits and vegetables your family eats?
11. Who and when do you eat more fruits and vegetable and why?
12. What do you think what could be done to increase overall mass consumption of fruits and vegetables?

Appendix 4: Interview Checklist for Key Informant Interview

B. KII checklist for expert-policymaker:

Participant:

Organization:

Date:

1. Do you think people in Bangladesh eat enough fruits and vegetable in their daily life in comparison to other low and middle-income countries (LMICs)?
2. Why are they eating less than required amount?
3. What are they eating instead?
4. What are the social, cultural or economic influences that cause people to eat the specific type of food more than the other in Bangladesh?
5. What is the most significant barrier to promote consuming fruits and vegetables in policy level? (Social, cultural, economic, supply chain etc.)
6. How to get over the barriers to increased consumption of fruits and vegetables? (individual to mass level)
7. What are the current foods or agricultural policy related to fruits and vegetable production and consumption?
8. What are the current foods or agricultural research related to fruits and vegetable production and consumption?
9. What policy recommendation will change the dietary habit towards increased consumption of fruits and vegetable?
10. Is there any organization taking practical measure on food safety, organic farming, co-operative market etc.?

Appendix 5: Survey Questionnaire with informed consent form

Household Survey For Patterns and Determinants of Consumers' Preferences and Demand for Fruits and Vegetables in Bangladesh

Assalamu Alaikum/Namashkar/Aadab,

My name is I have come from Center for Natural Resource Studies (CNRS). CNRS in association with Manitoba University, Canada, is conducting a survey for a thesis research. Various information of the households collected through this survey will create opportunity to measure the health, agriculture, socioeconomic indicators of this area. The result of this survey could also be used to future development programs. It is noted that information on Diabetes, Blood pressure, height, weight and MUAC are included in the health related information. There is no health risk during and after these measurements. If possible, we would collect information from all the households of this village. But it would take a lot of time. So, we have chosen some households randomly to get a picture of all the households of this village. Your household has been chosen by this process.

We are inviting you to participate in this survey. Please note that you are also one who will represent the households of this village. If you participate in this survey, your information will be accumulated with others participating in this village. The collective result from this process will be considered as the scenario of this village.

Information collection could take about 40 minute's time. You will not be provided with any honorarium or allowance. You have the right to withdraw yourself from this survey.

We cordially accepting your decision of participating in this survey. Your provided information will have an important role in future development programs of this area. You will be provided with a copy of this consent form for preservation.

If you agree to participate, please sign your full name:

Name and signature of witness:

Module 1: Household Identification Information

Name of the respondent		Question No.(QSINo)	
Telephone number		Member No.(MID Code)	

Module: 2 Employment status

ID CODE as in Roster	2_1	2_2	2_3	2_4	2_5
	What economic activities did (name) do in the past 12 months? Beside this,	On average how many days per month?	On average how many hours per day?	Where did you do this activity?	What was major field of economic activities you engaged in?
				Was it rural or urban area? 1 Rural 2 Urban	1 Agriculture 2 Non-agri
	Occupation Code	Days per Mont	Hours/Day		
A					
B					

Code for module 2

Occupation Code 2_1	
<ol style="list-style-type: none"> 1. Day labor (works for others) 2. Labor (work for himself) like Weaver, Blacksmith, Potter, Riksha driver etc. 3. Agriculture 4. Small business 5. Service 6. Student 7. Housewife 8. Unemployed 	<ol style="list-style-type: none"> 9. Retired 10. Expatriat (Specify, like write the job he or she does, if not known what he/she does, please write- not known) 11. Fisher 12. Village Doctor 13. No occupation 14. Not applicable 99. Others (specify)

Module 3: Income and wages

MID CODE	DAILY WAGE					SALARIED INCOME			SELF EMPLOYED INCOME	HH MONTHLY INCOME
	3_1	3_2	3_3	3_4		3_5	3_6	3_7		
	Were you paid on a daily basis?	What was the type of payment?	If the payment is in cash amount received per day	If the payment is in-kind, write down type, amount and price		What type of org. do/did you work for?	What is your gross remuneration per month?	What is your gross remuneration per month?		
	1 Yes 2 No (if no go to 3_5) 3 Self employed	1 Goods (go to 3_4) 2 Cash (go to 3_3)	taka	1 Paddy 2 Rice 3 Wheat 4 Meal 5 others	Quantity in kg Value in tk	1 Govt Organization 2 Private office 3 Govt/public factory 4 Private Factory 5 Local Govt 6 NGO 7 Household 8 Others	Taka	Taka		

Module 4: Knowledge and attitude about fruits and vegetables consumption

SL#	Statement	Code: 1-Strongly Agree; 2-Agree; 3-Not Sure, 4-Disagree; 5-Strongly Disagree		
		Knowledge (4_k)	Attitude (4_a)	Practice (4_p)
4_1	Consumption of vegetables and fruits is equally important as fish/meat			
4_2	Rice is more important than Vegetable in every day meal			
4_3	Every family should consume required amount for vegetable			
4_4	Every family should consume required amount for fruits			
4_5	Organic pesticide is harmless for health and nature			
4_6	Chemical pesticides are harmful for health and nature			

4_7	Vegetable can be eaten just after application of chemical pesticide			
4_8	Indigenous vegetable is more beneficial for health			
4_9	Vegetables produced with organic pesticide are better to eat			
4_10	Meat is preferable than vegetables			
4_11	Radio/Television should broadcast/telecass more program regarding organic fertilizer and organic pesticide			
4_12	Radio/Television should broadcast/telecass more program on the importance of vegetable and fruit consumption			
4_13	Vegetables are food for the poor			
4_14	Fish and meat are the food for the richer			
4_15	My family members don't eat enough vegetables			
4_16	My family members don't eat enough fruits			
4_17	Bland taste of vegetables is the reason why its not cooked			
4_18	Time consuming preparation time for leafy vegetable is the reason why its not cooked frequently			
4_19	Pesticides/formalin on fruits are more important reason than higher price why fruits are eaten less			
4_20	Pesticides on vegetables is more important driver in eating less vegetable even if the price is less			
4_21	If income rises more meat is bought than vegetables			
4_22	If income rises more rice is bought than vegetables			

Module 5: Lifestyle practice and uptake of social programme

SL#	Questions	Code
5_1	Do you smoke? Code: 1=Yes, 2=No (if yes go to 5_2)	
5_2	How many cigarettes do you smoke in a typical daycigarette
5_3	Do you take smokeless tobacco? Code: 1=Yes, 2=No (If yes ask 5_4)	
5_4	How many times do you take smokeless tobacco in a typical day	...times
5_5	Go out for a fast food or fried food? 1=Yes, 2=No (if yes ask 5_6)	
5_6	How many times a week?	...times
5_7	How many hours do you watch TV during a typical day?	...hours
5_8	Do you walk atleast half an hour everyday? 1=yes, 2=No	

5_9	Does your HH buy processed food? 1=yes, 2=No (If yes ask 5_10 and 5_11)	
5_10	Who buys them? See code	
5_11	Why do you prefer processed food? See codelist	
5_12	Is any member of the HH a member of a NGO/MFI? 1=yes, 2=no	
5_13	Is the member a male or a female? 1=Male, 2= Female	
5_14	Did you get any training on food behavior? 1= yes , 2=no	

Code for module 5:

Code 5_10	Code 5_11
<ul style="list-style-type: none"> 1. HH Head 2. Husband/ 3 wife 4. Son/Son in law/ 5 Daughter/ Daughter in law 6. Mother / Mother in law 7. Father/Father in law 8. Brother 9. Sister 10. Male Grandchildren 11 female grandchildren 12. Male in laws 13 Female in laws 14 Nephew 15 Niece 16 uncles 17 aunts 18. Employee/domestic worker 19. Lodging 20. Others (specify) 	<ul style="list-style-type: none"> 1 less price 2 Food doesn't rot easily 3 tastes better 4 less cooking time 5 less available time 6 available 7 easy to carry 8 refundable 9 Kids like it 99 others

Module 6: Intra household decision making and women engagement

SL#	Questions	Code
1.	Who takes the decision what to buy for the everyday meal? See code	
2.	Who takes the decision what f & v to buy? See code	
3.	Who buys the f & v for everyday eating? See code	

4.	Who cooks it? See code	
5.	Do the women eat at the same time with the family? 1=yes , 2=no	
6.	Do the women eat at the end? 1 = yes, 2=no	
7.	Do the lead women of the household earn? 1=yes, 2=no	
8.	Does she work outside or inside home? 1=yes, 2=no	
9.	In which sector? codelist	
10.	How much does she earn? Per month	taka
11.	How many hours does she work per day?	hour
12.	Does the lead woman go to the bazar by herself? 1=yes, 2=no	

Code list for Module 6

Code 6_1, 6_2, 6_3 & 6_4	Code 6_9
1. HH Head 2. Husband/ 3 wife 4. Son/Son in law/ 5 Daughter/ Daughter in law 6. Mother / Mother in law 7. Father/Father in law 8. Brother 9. Sister 10. Male Grandchildren 11 female grandchildren 12. Male in laws 13 Female in laws 14 Nephew 15 Niece 16 uncles 17 aunts 18. Employee/domestic worker 19. Lodging 20. Others (specify)	1. Day labor (works for others) 2. Labor (work for himself) like Weaver, Blacksmith, Potter, Riksha driver etc. 3. Agriculture 4. Small business 5. Service 6. Student 7. Housewife 8. Unemployed 9. Retired 10. Fisher 11. Village Doctor 12. No occupation 13. Not applicable Others (specify)

Module 7: Daily consumption of fruits and vegetables of the household head

SL	7_1 Name	7_2 code	7_3 Quantity (gm)	7_4 Serving size	7_5 1. Purchase (go to 7_6); 2. Wage in-kind 3. Self Prod. 4. Gift 5. Collected	7_6 If purchased, from where? 1.Producer 2. Local market 3.Hawker 4.Retailer 5.Superstore
	vegetables					
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
	Fruits					
11						
12						
13						
14						
15						

Code for Module 7: Daily consumption of fruits and vegetables of the household head

Vegetables name	1. Cabbage, 2. Cauliflower, 3. Radish, 4. Yard long bean, 5. French bean, 6. Sweet gourd, 7. Bottle gourd, 8. Cucumber, 9. Ribbed gourd, 10. Sponse gourd, 11. Bitter gourd, 12. Teasle gourd, 13. Pointed gourd, 14. Snake gourd, 16. Brinjal, 17. Tomato, 18. Okra, 19. Stem amaranth, 20. Red amaranth, 21. Indian spinach, 22. Spinach, 23. Bathua , 24. Kangkong , 25. Sweet potato, 26. Carrot, 27. Eddoe , 28. Taro, 29. Drumstick, 30. Green papaya, 31. Jute leaf, 99. other
Fruits name before correction	1. Lemon, 2. Satkara, 3. Lime, 4. Jackfruit, 5. Guava, 6. Wood apple, 7. Litchi, 8. Pineapple, 9. Jujube, 10. Olives, 11. Tamarind, 12. Mango, 13. Banana, 14. Coconut, 999. Others
Fruits name After correction	32. Lemon, 33. Satkara, 34. Lime, 35. Jackfruit, 36. Guava, 37. Wood apple, 38. Litchi, 39. Pineapple, 40. Jujube, 41. Olives, 41. Tamarind, 43. Mango, 44. Banana, 45. Coconut, 999. Others

Module 8: Monthly fruits and vegetables expenditure

SL #	Item	Co de	Winter				Summer								Rainy Season								Winter			
			Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			Magh		Falgun		Choitro		Boishakh		Joishtho		Ashar		Srabon		vadro		ashin		kartik		ogrohayon		Poush	
			Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk		
	8_1	8_2	8_3 q	8_3 t	8_4 q	8_4 t	8_5 q	8_5 t	8_6 q	8_6 t	8_7 q	8_7 t	8_8 q	8_8 t	8_9 q	8_9 t	8_10 q	8_10 t	8_11 q	8_11 t	8_12 q	8_12 t	8_13 q	8_13 t		
	Vegetables																									
1	Cabbage	1																								
2	Cauliflower	2																								
3	Radish	3																								
4	Yard long bean	4																								

			Winter				Summer								Rainy Season								Winter			
SL #	Item	Code	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			Magh		Falgun		Chaitro		Boishakh		Joishtho		Ashar		Srabon		vadro		ashin		kartik		ogrohayon		Poush	
			Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk
	8_1	8_2	8_3q	8_3t	8_4q	8_4t	8_5q	8_5t	8_6q	8_6t	8_7q	8_7t	8_8q	8_8t	8_9q	8_9t	8_10q	8_10t	8_11q	8_11t	8_12q	8_12t	8_13q	8_13t	8_14q	8_14t
5	French bean	5																								
6	Sweet gourd	6																								
7	Bottle gourd	7																								
8	Cucumber	8																								
9	Ribbed gourd	9																								
10	Sponse gourd	10																								
11	Bitter gourd (small)	11																								
12	Teasle gourd	12																								
13	Pointed gourd	13																								
14	Snake gourd	14																								
15	Potato	15																								
16	Brinjal	16																								
17	Tomato	17																								
18	Okra	18																								

			Winter				Summer								Rainy Season								Winter			
SL #	Item	Code	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			Magh		Falgun		Choitro		Boishakh		Joishtho		Ashar		Srabon		vadro		ashin		kartik		ogrohayon		Poush	
			Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk
	8_1	8_2	8_3q	8_3t	8_4q	8_4t	8_5q	8_5t	8_6q	8_6t	8_7q	8_7t	8_8q	8_8t	8_9q	8_9t	8_10q	8_10t	8_11q	8_11t	8_12q	8_12t	8_13q	8_13t	8_14q	8_14t
19	Stem amaranth	19																								
20	Red amaranth	20																								
21	Indian spinach	21																								
22	Spinach	22																								
23	Bathua	23																								
24	Kangkong	24																								
25	Sweet potato	25																								
26	Carrot	26																								
27	Eddoe	27																								
28	Taro	28																								
29	Drumstick	29																								
30	Green papaya	30																								
31	Jute leaf	31																								
32	others	99																								
33	Fruits																									
34	Lemon	32																								
35	Satkara	33																								

			Winter				Summer								Rainy Season								Winter			
SL #	Item	Code	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			Magh		Falgun		Choitro		Boishakh		Joishtho		Ashar		Srabon		vadro		ashin		kartik		ogrohayon		Poush	
			Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk
	8_1	8_2	8_3q	8_3t	8_4q	8_4t	8_5q	8_5t	8_6q	8_6t	8_7q	8_7t	8_8q	8_8t	8_9q	8_9t	8_10q	8_10t	8_11q	8_11t	8_12q	8_12t	8_13q	8_13t	8_14q	8_14t
36	Lime	34																								
37	Jackfruit	35																								
38	Guava	36																								
39	Wood apple	37																								
40	Litchi	38																								
41	Pineapple	39																								
42	Jujube	40																								
43	Olives	41																								
44	Tamarind	42																								
45	Mango	43																								
46	Banana	44																								
47	Coconut	45																								
48	Others	999																								

Module 9: Monthly other food expenditure

			Winter				Summer								Rainy Season								Winter				
SL #	Item	Code	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		
			Magh		Falgun		Chaitro		Boishakh		Jyeshtha		Ashar		Srabon		vadro		ashin		kartik		ogrohayon		Poush		
			Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	Qty	tk	
	9_1	9_2	9_3q	9_3t	9_4q	9_4t	9_5q	9_5t	9_6q	9_6t	9_7q	9_7t	9_8q	9_8t	9_9q	9_9t	9_10q	9_10t	9_11q	9_11t	9_12q	9_12t	9_13q	9_13t	9_14q	9_14t	
	Rice	50																									
	Flour	51																									
	Pulses	52																									
	Small Fish	53																									
	Large Fish	54																									
	Eggs	55																									
	Chicken/Duck	56																									
	Beef	57																									
	Mutton	58																									
	Milk & Dairy	59																									
	Sweetmeat	60																									
	Oil & Fats	61																									
	Tea coffees	62																									
	Sugar	63																									
	Satl	64																									
	Miscellaneous Food (sauce/jelly/pickles)	65																									
	Dining out (Food outside)	66																									
	Tobacco	67																									

			Winter				Summer								Rainy Season								Winter			
SL #	Item	Code	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			Magh		Falgun		Chaitro		Boishakh		Joishtho		Ashar		Srabon		vadro		ashin		kartik		ogrohayon		Poush	
			Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk	Qt y	tk
	9_1	9_2	9_3q	9_3t	9_4q	9_4t	9_5q	9_5t	9_6q	9_6t	9_7q	9_7t	9_8q	9_8t	9_9q	9_9t	9_10q	9_10t	9_11q	9_11t	9_12q	9_12t	9_13q	9_13t	9_14q	9_14t
	Bettle leaf	68																								
	Bettle nut	69																								
	Onion	70																								
	Garlic	71																								
	Ginger	72																								
	Turmeric powder	73																								
	Red chili powder	74																								

Module 10: Monthly non food expenditure

			Winter				Summer								Rainy Season								Winter			
SL#	Item	Code	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
			Magh		Falgun		Chaitro		Boishakh		Joishtho		Ashar		Srabon		vadro		ashin		kartik		ogrohayon		Poush	
			Total cost		Total cost		Total cost		Total cost		Total cost		Total cost		Total cost		Total cost		Total cost		Total cost		Total cost		Total cost	
	10_1	10_2	10_3j		10_4f		10_5m		10_6a		10_7y		10_8j		10_9l		10_10g		10_11s		10_12c		10_13n		10_14d	
1	Fuel and Lighting	72																								
2	Cosmetics and Other Expenses	73																								

			Winter		Summer				Rainy Season				Winter	
SL#	Item	Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			Magh	Falgun	Chaitro	Boishakh	Joishtho	Ashar	Srabon	vadro	ashin	kartik	ogrohayon	Poush
			Total cost	Total cost	Total cost	Total cost	Total cost	Total cost	Total cost	Total cost	Total cost	Total cost	Total cost	Total cost
	10_1	10_2	10_3j	10_4f	10_5m	10_6a	10_7y	10_8j	10_9l	10_10g	10_11s	10_12c	10_13n	10_14d
3	Washing and Cleaning Expenses	74												
4	Transport/ Travel and Other Misc. Charges	75												

Module 11: Annual non food expenditure

SL#	Item	Code	Total Cost
	11_1	11_2	11_4
1	Ready-Made Garments	76	
2	Footwear	77	
3	Medical treatment	78	
4	Housing related expense	79	
5	Educational expenses	80	
6	Ceremonies	81	
7	Cooking equipment	82	
8	Furniture	83	
9	Household durables (PC, radio, printer)	84	

10	Tax and insurance	85	
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-Our interview has been ended. Thanks for your time-
